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ART. I.—*Some Experiments on Sonorous Flames, with Remarks on the Primary Source of their Vibration;* by Prof. WILLIAM B. ROGERS.*

THE production of a musical sound by a small flame of hydrogen gas burning within a tube has long been one of the most familiar of lecture-room experiments. Prof. Faraday, early in his marvellous career of discovery, showed that this musical vibration was not confined to hydrogen but could be produced with flames of carbonic oxyd, olefiant and common illuminating gas as well as several other gases and vapors; and he was the first to give a philosophical theory of the sound, by rendering it probable that in the conditions of the experiment the flame resolved itself into a series of little explosions, which succeeding each other at very small and equal intervals gave rise to regular and therefore musical vibrations in the tube. This theory afterwards confirmed by an experiment of Prof. Wheatstone, in which, with his well-known revolving mirror, he rendered visible the intermitting combustion of the singing flame, has lately received a further illustration from Prof. Tyndal's ingenious arrangement for observing the successive images of the flame as reflected upon a screen.

The recent beautiful experiments of Count Schaffgotsch and Prof. Tyndal proving that in certain conditions the flame is strongly impressible by external sounds, have given a new and

* Read before the Am. Association for the Advancement of Science, May 4, 1858.

unexpected interest to the subject, as is well shown in the curious observations of Prof. LeConte in the January number of the Am. Journ. of Science; and I need hardly add that they have also prompted the experiments and reflections embodied in the present paper. In presenting these I shall follow the order in which the experiments were made and from time to time communicated to the Boston Nat. Hist. Soc., and the American Academy during the past winter.*

1. *Production of musical sounds by flames escaping from wicks or wire-gauze.*—Early in these experiments I found that the usual absence of the sonorous effect in the case of lamps or candles burned under the same conditions as the gas, is not due, as might be supposed, to a mechanical interference of the wick with the vibrating motion. Wicks of cotton thread and of asbestus introduced into a jet-pipe of coal-gas one-tenth of an inch in diameter do not prevent the singing even when they project far into the flame, and unless spread out raggedly at the sides do not greatly impair the purity of the tone. Indeed the difficulty of obtaining continuous musical sounds from a common flame with a wick would seem to be due rather to the nature of the combustible matter, which requiring a very large supply of air to produce the explosions and evolving too little heat in combustion, is liable to be extinguished before the musical sound is developed.

By using a small alcohol lamp with a wick-tube about five inches high and one-fifth of an inch in diameter, I have succeeded in obtaining a very pure musical tone, when the blue and low flame was introduced into a resonant tube five or six feet long. The effect occurs only at a particular stage of the flame, and depends on so nice an adjustment between this and the tube as to make its repetition difficult and uncertain. With sulphuric ether the same arrangement is more frequently successful, but even this furnishes only capricious results.

To obtain an ether flame which will readily assume the sonorous state I use a lamp consisting of a glass tube about eight inches long and one-fourth inch in diameter, open below and drawn somewhat bluntly to a small aperture at top. Into this some loose cotton twine or thread of asbestus is introduced so as to terminate at or very near the pointed opening. The tube is then half filled with sulphuric ether, the larger end closed with a tight cork, and the little ether lamp fixed upright in the centre of a wooden block. On applying a light to the apex the ethereal vapor burns in a steady jet, which with proper tubes enables us readily to repeat most of the experiments on the singing flame. This simple apparatus acts freely at ordinary tem-

* My earlier experiments and the general theory of the vibration as explained towards the close of this article were presented at a meeting of the Warren Club late in December.

peratures and may be used from time to time for several days without replenishing.

Finding that the ordinary solid wick gave such unsatisfactory results even with an ether flame, it occured to me that a hollow wick by its larger exposure to the air would be more favorable to the formation of the explosive mixture, and therefore to the production of the sound. This, on trial, proved to be the fact. By using *hollow wicks*, and resonant tubes but slightly exceeding them in diameter, I was able to obtain the musical effect, with the flames of sulphuric ether, common alcohol, and the mixture of the latter with spirits of turpentine, which is known in this country as burning fluid, and by employing an iron tube at a high temperature with such a hollow wick I have obtained, though less perfectly, a musical note from the flame of spermaceti oil.

These results may be readily obtained with the flame of the small circular-wick lamp now in use for burning the mixture of alcohol and turpentine. In this form of lamp the wick-tube rises about two and a half inches above the reservoir, and an external movable tube is provided, which being raised or lowered serves to vary the depth of the wick on the outside and to adjust the flame with great nicety. This appendage is important also as a means of giving the exterior of the wick a smooth outline and securing an even action of the converging streams of air on the flame. The body of the lamp should be removed from its pedestal and placed on a ring-support to secure a free current of air upward through the central wick-tube.

As the effect in these experiments depends upon the access to the flame of a current of air of definite amount and velocity and in a proper direction, it is necessary to adjust the height of the flame and its position within the resonant tube to the dimensions of the latter. With a tube two feet long the flame should be short and placed so that its base may be about on a level with the lower edge of the tube. With one five or six feet in length we must use a higher flame and depress the tube an inch or more below its base. When this is done the flame will be seen to contract and lose much of its brilliancy, at the same time giving forth a musical tone which, with a little care in holding the tube, may be kept quite smooth and continuous. As a more precise guide to those who may wish to repeat this experiment it is proper to mention that the lamp above referred to has a sliding tube of about nine-tenths of an inch in diameter and an inner tube of nearly five-tenths, and that the resonant tubes best adapted to it are from twelve to fifteen-tenths of an inch in diameter, and from eighteen inches to six feet long. With these arrangements an *alcohol wick-flame affords a clear musical sound with as much certainty and ease as an Argand gas-flame.*

Those who are familiar with such experiments are aware that by the ordinary procedure a bulky flame of illuminating gas cannot be made to assume the sonorous state. Yet as might be expected when such a jet is mingled with a sufficient proportion of common air, it does not fail, with a suitable resonant tube, to yield a powerful musical tone. To bring about this result the air may be applied as a current to the surface of the flame, or it may be mixed with the gas below the place at which the combustion begins. As the effects of the former process will be shown under a subsequent head, I will confine myself to an exemplification of the latter as presented in the sonorous character of the large flame of mixed air and coal gas formed on top of a wire-gauze burner, when properly adjusted. In the ordinary arrangement of such burners the proportion of air which becomes mingled with the gas before passing through the meshes of the gauze to form the flame, is quite insufficient to bring it to the state of an explosive mixture. By perforating the sides of the chamber beneath the gauze with numerous openings and allowing also a wide entrance for the air below, we provide an efficient means for admitting a large volume of air, and for thoroughly mingling it with the gas.

The effect of such an arrangement is strikingly seen in the powerful sonorous vibrations first noticed by Mr. W. F. Shaw of this city while experimenting with the *wire-gauze burners* which he uses in his gas stoves. On inverting one of these burners over the jet so as to bring the perforated cylinder below and the continuous metal tube above the diaphram of gauze, he found that the flame when duly adjusted gave rise to a very loud continuous musical sound which could be changed in pitch and strength by the addition of other pipes above. With a large volume of flame the tone, as I have repeatedly experienced, becomes painfully intense, as indeed it should be, considering the energy of each of the successive explosions by which it is maintained. It may perhaps be supposed that the powerful current drawn upward into the tube by the heating action of so large a flame would by its direct mechanical agency contribute largely to the production of the sound. This however is shown not to be the case by the necessity of a special adjustment of the supply of gas, and the cessation of the sound when the quantity is much increased.

2. *The sonorous state may be induced by giving a rapid motion to the flame.*—When a jet of burning coal-gas is introduced into the resonant tube in a position in which it does not sing spontaneously we may cause it to commence its musical performance by simply *vibrating the jet-pipe rapidly from side to side.* In this experiment the pipe should be covered with soft buckskin for two or three inches near its upper end to prevent the sharp jar-

ring sound caused by its striking the glass. This movement of the jet is so efficient in bringing on the sonorous state that it will compel the flame to sing even in a tube in which it would not do so spontaneously in any position in which we could place it. Indeed it will often excite the musical vibrations in cases where from the unsuitable proportions between the tube and flame the external sounds used in Schaffgotsch's and Tyndal's experiments entirely fail to bring on the sonorous state.

Fig. 1, A, represents an arrangement which I have found well suited for this experiment. The jet-pipe, about ten inches long, has an aperture above of $\frac{1}{50}$th of an inch in diameter, and is attached to the metal gas-stand beneath by a piece of rather stiff vulcanized tube, of which about one inch of the middle portion is free to vibrate. The motion is given by applying the fingers to the upper part of the elastic tube, and may easily be varied in speed and restricted in distance as we desire.

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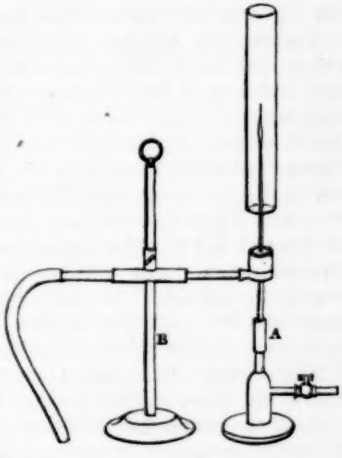

Although the singing is induced more promptly when we allow the jet-pipe in its vibrations to strike the sides of the tube, this action is not at all necessary to the effect, for we obtain the same result when the pipe is merely shaken to and fro within such limits as to prevent its touching the glass. The effect here described, is so striking and beautiful that when first observed it cannot fail to excite surprise, especially if from previous trials we have found that the flame refuses either to sing spontaneously or under the action of external sounds.

So far as the impulse of the jet-pipe against the sides of the tube is influential in exciting the sound, we must ascribe its action to the feeble musical resonance produced by it within the tube, which although composed of several sounds may always be observed to include the fundamental note of the tube. This action is therefore like that of a unison note sounded by the voice or an external instrument or that of any other mechanical agency giving rise to a vibration of the included column of air. But the other and far more remarkable effect, the excitement of the musical condition in the flame by simply moving it to and fro without striking the tube, cannot be thus explained since the gentle impulses given to the air by the vibrating pipe produce

no audible effect and would seem quite inadequate to excite in the column any but the very feeblest vibration. Admitting however that these extremely faint vibrations of the air may contribute somewhat to the result, it can hardly be doubted that the main influence by which the movement of the jet produces the effect in question is by causing so rapid a mixture of the adjoining air with the gas that the latter before being inflamed is brought into a condition to produce those small explosions, which, by their quick succession, give origin to the sound. The effect of motion in bringing about this explosive condition of the flame is well exemplified by the following experiment.

Fastening a jet-pipe, some twelve inches in length, into the end of the long flexible tube through which the gas is supplied, and holding it erect by a point a little below the insertion so that we can readily cause it to vibrate, we ignite the gas and adjust it to form a slender flame about an inch long. If now the flame be moved from side to side through a distance of five or six inches, at a moderately rapid rate, it will assume, according to a well known visual law, the appearance of a continuous arch of whitish light, retaining at the extremities the whole height of the stationary flame, but growing narrower from either side towards the middle. In these conditions the flame is *entirely noiseless.* As we gradually increase the speed of the vibrations, the arch, at a certain velocity, suddenly breaks in the middle, where a faint bluish flame takes the place of the usual whitish light, and at the same instant a *sharp noise is heard* due to the inflamation of the explosive mixture at this part of the vibration. It is hardly necessary to say that as the vibration is quickest at the midway point, coming to a pause at each end of the arch, the gas becomes more largely mixed with air at the middle than towards the extremities of the motion, and is therefore at this point earliest reduced to the state of an explosive mixture.

As we increase the velocity of the vibrations, the sonorous part of the arch extends towards the ends until the path of the flame presents the aspect of a narrow bluish band irregularly serrated at top and flanked at the extremities by a tall flame of the usual whitish color. As might be expected when the jet is revolved rapidly in a circle the white light entirely disappears and the ring of bluish flame which results gives forth a continuous but not distinctly musical sound. When made in a dark room these simple experiments were found to be unexpectedly interesting and beautiful.

The sound familiarly observed when a flame of any kind is blown upon, and especially when the air is forced into and through the flame, as in the case of the jet of a blow-pipe, was long ago referred by Faraday to the combustion of an explosive mixture formed by the air and burning matter. The sound pro-

duced by a blazing fire of wood or bituminous coal contrasted with the silence of a flameless mass of ignited anthracite is an obvious illustration of the same principle. But the experiments above described show the operation of this law under conditions which enable us more satisfactorily to mark the origin of the sound and the gradations by which it accompanies the formation of the explosive mixture.

3. *The sonorous state may be induced by causing an additional supply of air to pass up the resonant tube.*—As in the above cases the action was mainly traceable to the more rapid mingling of the atmospheric air with the flame, it was natural to conclude that a like effect would be produced by passing a current of air upward through the tube, and on trial this anticipation was strikingly verified. In order that the current may be evenly distributed it is convenient to employ an argand burner having the supply pipe at the side and the central opening entirely free, so that the jet-pipe may rise through the centre, and the burner be adjusted to the proper distance below the flame and the bottom of the glass tube. The air conveyed to the argand burner through a flexible pipe may be supplied either from the lungs of the operator or from an adjacent gasometer. In most cases the action of the current is more easily managed when the apertures from which it flows are some two or three inches below the bottom of the resonant glass tube. Fig. 1, B, represents the air jet in connection with the other parts as adjusted for experiment.

With this arrangement and a proper graduation of the current of air impelled into the tube we can cause the flame to sing when the other methods above described have failed to produce any effect. When the flame is not far from the position in which it would spontaneously sing, the *lightest breathing through the argand pipe is sufficient to bring it to the sounding state* and to maintain a clear smooth tone. Even when the flame is large and otherwise not readily susceptible of the sonorous action, a stronger current of air applied nearer to the bottom of the resonant tube will rarely fail to bring on the musical vibrations.

In adjusting the argand jet-pipe to the most suitable position for this effect we should be guided by the other conditions of the experiment. When the resonant tube is of moderate size, for example, three-fourths of an inch or an inch in diameter, and the flame not greatly larger than is suited to spontaneous singing, in other words, when only a small additional supply of air is required for the effect, the current will be found more manageable if made to ascend from a distance of two or three inches below the mouth of the tube. Using a much larger flame in the same tube, we must of course apply a stronger current to supply the requisite amount of air, and must therefore

bring the air-jet closer to the opening of the tube at the same time that we augment the force of the blast. With a tube of glass five feet long and two and a half inches in diameter and a gas-flame two inches high proceeding from an aperture of $\frac{1}{50}$th of an inch, I find it best to bring the argand jet a little within the tube. Then by a gradually increasing blast I soon bring the flame to the sonorous state and obtain a deep and powerful organ-tone.

In most cases the effect above described can be produced in a simpler but less satisfactory manner by using, instead of the argand burner to conduct the current of air, a common glass tube bent suitably, and held near the jet-pipe below or just within the opening of the resonant tube.

To show that the mechanical action of the air upon the lower edge or the inner surface of the tube has no direct effect in producing the musical tone, it is only necessary to repeat the experiment after extinguishing the flame, when it will be seen that the current of air alone gives rise to no decided sound.

The effect of a due admixture of air in bringing on the sonorous state is still more strikingly exhibited when we use a concentric jet-pipe in which the current of air is blown through a central aperture in the midst of an annular stream of gas. With such an arrangement and a proper force of blast from the lungs or a gasometer, we may reduce a silent flame two or three inches in height to a short blue sonorous jet, which with a suitable enclosing tube will give rise to a sound of great volume and intensity. Using the larger tube (five feet by two and a half inches) before mentioned, I find it easy in this way to produce a tone of almost deafening loudness or one of great smoothness and purity, by increasing or lessening the supply of gas and of air.

The preceding observations agree with those of other experimenters in favoring the conclusion that *flames of everg kind are capable of exciting sonorous vibrations*, provided the air and combustible gases or vapors are brought together in such proportions as to form an explosive mixture, and they therefore confirm the explanation of Faraday which refers the musical sounds produced in such cases to a rapid and uniform succession of small explosions.

4. *The intermissions of the singing flame are made visible by giving it a rapid vibrating or revolving motion.*—The intermitting character of the combustion in a singing flame has been beautifully shown by Prof. Tyndal by causing the light of the flame to fall upon a revolving mirror from which it is reflected so as to form a series of images on a distant screen. A similar resolution of the flame into successive explosions is more simply exhibited by moving it rapidly to and fro, or better still, by giving it a steady revolving motion within the tube. In using the for-

mer method the jet-pipe attached to the common gas stand by a short piece of flexible hose may be passed through a ring so placed as to restrict the vibrations to a range less than the diameter of the tube. A sufficiently regular movement may then be given by the hand. If now we adjust the flame in the tube so that it will not begin to sing for some time after the vibration has commenced or until the tube is farther lowered, we observe at first merely the continuous band of light due to the permanence of the visual impression, but as soon as the singing commences this band becomes waved or serrated at top and with a proper velocity divides into nearly separate columns of flame with obscure spaces between.

The effect is however far more striking when *the flame is made to revolve at a uniform rate in the tube.* In this case so long as it remains silent it presents the appearance of a hollow cylinder or short tube of whitish light, but the moment that the singing begins the cylinder assumes a toothed form on the top resembling a brilliant crown and *divides itself into a number of narrow luminous columns separated by bands nearly or quite deprived of light.* As might be expected, the number of these subdivisions, with a given rate of rotation, is greater in a short tube than in a long one and is greater when the tube is yielding one of its harmonic notes than when giving its fundamental sound. In the same tube the number of subdivisions diminishes as we increase the velocity of rotation, a less number of vibrations or explosions in this case corresponding to one revolution of the jet.

To render the effect visible at a distance it is of course necessary to use a large tube and flame. It is however beautifully distinct when the tube is some six feet long by one and a half inches in diameter and the flame three-fourths of an inch in height. The mechanism employed to give rotation to the jet consists of a grooved wheel connected by a band with a small pulley (fig. 2). Into the latter the supply-pipe enters from below by a smooth gas-tight joint which allows the pulley freely to revolve. The jet-pipe secured to the middle of the upper face of the pulley tapers to the extremity, and rising to the height of six or eight inches is elbowed near the top so as to give the flame when revolving an orbit of about an inch in diameter.

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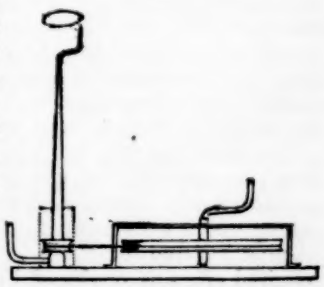


To secure the pipe more firmly in its upright position it is made to pass near its base through a narrow gallows of brass in which

it turns freely. This, which is represented in the figure by the dotted lines, has two little cushions of buckskin glued on the top, for the convenience of supporting the larger tubes during the experiment.

In making this experiment it will be remarked that although in the first instance the rotation of the flame often serves to excite the vibration, an increase of velocity weakens the force of the sound, and a very high speed actually annuls it, the flame at the same time resuming its normal appearance of continuity. This effect is not due, as might be supposed, to the air carried round by the revolving motion obstructing the full supply of oxygen to the flame, for I have found that it is not perceptibly increased by attaching a disc of card to the revolving arm of the jet-pipe, and moreover I have observed that a small singing flame after being silenced by very rapid rotation shows throughout its circuit the blue column due to a full admixture of air. More probably the cause of this weakening and destruction of the sound should be sought for in the mechanical interference of the successive pulses due to explosions at widely separated points in the orbit of the flame; but further observations are needed clearly to explain the effect.

As in the explosive state the flame has extremely little illuminating power, we must conclude that in the above as well as the following experiments, the obscure intervals mark the periods of explosion, and the bright ones the periods in which the gas burns in the ordinary way with a luminous white flame.

5. *The intermissions of the singing flame are made apparent by a moving object which it illuminates.*—While the experiment above described is in progress the appearance of the horizontal arm of the jet-pipe affords incidentally a pretty proof of the intermittence of the singing flame. As the recurrence of the bright flame between the successive explosions makes this part of the pipe strongly visible, it assumes the aspect of a number of spokes corresponding to the subdivisions of the crown of flame; and if to vary the effect we blacken the horizontal arm and fasten near its outer end, or where it assumes the vertical direction, a brilliant bead of glass or metal, we are presented with a circle of starry points each of which by a proper adjustment of the motion appears to be at rest.

The following proof of the intermitting nature of the singing flame, suggested by the effects just described, is at once so simple and so readily seen at a distance, as perhaps to merit a place among useful lecture-room illustrations. In this experiment the jet-pipe bearing the flame is held at rest in the tube and the required effect is produced by receiving the light on a circular disc of thick pasteboard or of metal some six inches in diameter, supported near the tube on a horizontal axis around which it

may be revolved by the impulse of the hand. The face of the disc next the tube, colored of a dead black with paint or a covering of cloth, should have a narrow strip of white paper fastened upon it in a radial direction, or a small circular bit of the same placed near the edge. If both faces are used alternately we may affix the white bar to one and the dot to the other. On bringing the six-feet tube down over the flame and giving rapid motion to the disc, we remark that so long as the flame continues silent the bar or dot is quite invisible, but as soon as the sound commences the black disk becomes diversified by a series of whitish images of one or other of these objects arranged at equal intervals around the central point. It is scarcely necessary to say that the number of these images as well as their apparent motion and rest will depend on the time of rotation as compared with the interval of the explosions of the flame. Should it happen that the period of one revolution of the wheel is precisely that of a certain number of the explosions neither more nor less or that of any multiple or sub-multiple of this number, the images of the bar or dot will continue in each successive rotation to present themselves at the same points, but should such a relation not subsist these images will be seen to shift their places on the disc sometimes appearing to advance and at others to retreat.

6. *On the primary source of the vibration of singing flames.*—The preceding experiments taken in connection with those of Faraday, Wheatstone, Tyndal and others, afford conclusive proof that *the immediate cause* of these vibrations is to be found in the periodically explosive combustion of the gas. But the important inquiry still remains, *whence arises this periodicity*, why, instead of being uniformly continuous, is the combustion of the singing flame regularly intermitting in its character?

In seeking to account for this peculiarity of the combustion we are at once led to inquire whether it may not originate in a vibratory motion proper to the jet of gas, independent of its burning. Even were we unprovided with direct proof of such vibratory motion in jets of air, we might, with some probability, infer its existence from the similarity of effects produced on flames and on water jets by external sounds; and this is the course of argument used in the interesting paper of Prof. LeConte published in a late number of the Am. Journal of Science. But happily we are not left to the guidance of analogies or plausible conjectures in deciding this matter. Some experiments of Savart* and more recently the elaborate researches of Masson† and Sondhauss‡ have furnished abundant

* It appears that these results announced by Savart in his Lectures on Acoustics in the College de France were published by Masson in the Journal d'Institut.

† Annales de Chimie et de Physique, 3e Ser., xl, xli.

‡ Annalen der Physik und Chemie. Band xci.

positive evidence of the vibratory movement of jets of air flowing through small apertures. As these important results appear to have escaped the attention of Prof. LeConte and other late writers on sonorous flames, a particular reference to them may be useful in this place.

Felix Savart, as is well known, demonstrated the existence of vibrations in liquid jets, traced them to their source near or at the aperture, and showed that they were not only susceptible of being variously modified by tones of proper pitch sounded near them, but were capable under certain conditions of emitting of themselves distinct musical sounds. He did not however stop here, but in the words of M. Masson, "including all fluids in a general theory attempted to reproduce with gases the beautiful phenomena which he had demonstrated in regard to liquid jets." According to the same authority, "he showed by several experiments that water and elastic fluids present the same phenomena in their efflux." By a method described at length in Daguin's excellent Traite de Physique (vol. 1, p. 524) he proved that *a jet of air escaping from a vessel through a small aperture exhibits a succession of enlargements and contractions in its course similar to those seen in a jet of water.*

These conclusions have since been confirmed and extended by Masson, who, from an elaborate series of experiments, has demonstrated,

First—That the flow of air or gas through an aperture in a metal plate is not continuous but periodically variable, and that the aperture is the seat of a vibratory movement which produces a sound by acting on the exterior air.

And *Second*—That the number of vibrations performed by the air at the aperture is directly as the square root of the pressure, and is independent of the diameter of the orifice.

Referring to experiments with sonorous tubes placed in connection with such apertures, Masson has shown

First—That the sound of a sonorous tube is primarily produced *at the aperture* by the periodically variable flow of air and

Second—The sound of the aperture is re-enforced by the sonorous tube when the tone of the latter is exactly or nearly an harmonic of that of the orifice, so that the same mode of vibration may be excited in the tube by very different sounds of the orifice.

Among other results bearing upon the present enquiry, this able experimentalist states the important fact, that the vibrations proper to the orifice and those of the column of air in the sonorous pipe re-act upon each other so as to produce a unison of the different parts of the system, although these separately taken would originate different sounds. It will readily appear that this extension of Savart's well known principle of

the vibration of systems is directly applicable to the phenomena of sonorous flames.

By an independent series of experiments, Sondhauss has been led to similar conclusions as to the mechanical condition of the air-jet and has furthermore attempted to account for its vibration, as had been previously done by Cagniard-Latour, by the friction of the issuing column against the sides of the aperture. Among various important observations recorded in his elaborated memoir the following will strike the reader as interesting from its analogy with some of the phenomena of singing flames.

He states that *on sounding an organ pipe near the aperture we observe certain sounds of the pipe to be accompanied by a secondary sound produced by the air-jet which is either in unison with that of the pipe or an octave below it.* Have we not here an exact counterpart of the beautiful experiment of Tyndal and Schaffgotsch, in which the silent plane is made to sing by sounds of a certain pitch produced in its vicinity? Alluding to this observation of Sondhauss, Masson suggestively remarks, "that the fact seems to him to admit of no other explanation than that which Savart has given of the influence of external sounds on liquid jets."

It should be added that both Masson and Sondhauss have proved that neither the material of the aperture nor its shape have any influence on the cause which produces the sonorous vibration of the air-jet.

The above brief reference to the discoveries of Savart and those who have followed in the same line of investigation is sufficient to show that jets of air under the conditions of these experiments, and doubtless all air-jets, in a degree, are, at the moment of efflux, impressed with a vibratory or periodical movement, and that *this is the primary source of the vibration in singing flames.*

In view of these facts we may describe the principal phases in the production of the singing flame, briefly as follows.

First. Every jet of gas and therefore of flame is at all times the seat of a vibratory motion, but under ordinary circumstances this is too feeble to produce either audible or visible effects.

Second. When the jet is placed in conditions to favor an explosive combustion the remissions and intensions of the jet due to the vibratory motion, render the explosions more or less discontinuous, and thus add greatly to the energy of the vibrations.

Third. These vibrations of the explosive flame occurring within a resonant tube of suitable proportions, become accumulated and re-enforced, until by the mutual reaction of the vibrating jet and the air column a unison is produced corresponding more or less nearly to the fundamental note, or one of the harmonics of the tube.

It thus appears that the vibratory movements of singing flame are directly traceable to mechanical conditions which have been *actually proved* to exist in air-jets at the moment of their efflux. We are therefore not called upon to resort to conjectural properties of gaseous streams in order to explain them.

As to the mode in which these primary vibrations are excited at the aperture, whether by friction or some other special cause, we are not perhaps prepared in the existing state of our knowledge to form a satisfactory theory. But whatever may be their cause, few I think will be disposed to explain them by any assumed *cohesive action* of the particles of the gaseous stream. The analogy between jets of air and those of liquids so far as these vibrations are concerned, has been shown by Masson and Sondhauss to be only partial, but even were it more complete we could have no difficulty in admitting that the impelling forces, in the one case the elasticity of a pent-up mass of air, in the other the weight of a liquid column, must produce effects in many respects *alike* upon the issuing streams of gas and liquid.

In attempting to apply the theory of liquid jets so beautifully developed by Plateau to jets of gas, we are obliged with Prof. LeConte to ascribe to the gaseous molecules a mutual cohesion sufficient to mould the issuing stream into alternating enlargements and contractions, or in other words we must suppose them to be actuated by a cohesive force exceeding their repulsion. It is hardly necessary to say that this assumption is opposed to the unquestionable fact that it is a molecular repulsion which drives the particles through the aperture, and that the same force *acting in the jet* causes it when received into a vacuum rapidly to diffuse itself in all directions. The gaseous state is but another name for ponderable matter composed of self repellant particles; nor so long as this state continues can we conceive the particles to be controlled by the opposite or cohesive power. Taking the view adopted by some that both these forces are at all times present in gases, we must still allow a great preponderance of repulsion, to account for the mechanical properties of the mass. When by strong compression the gas is brought near its point of liquefaction, we may conceive this relative preponderance of repulsion to grow rapidly less and thus to cause the departure from the law of Marriotte which has been observed. But evidently until the molecules are in the act of uniting in the liquid form, repulsion must be their predominating force. The deviation from Marriottes' law marks only a decreasing rate of repulsion, not an efficient energy of cohesion among the particles, *the latter not coming into play until the particles are actually coalescing to form the liquid mass.*

As regards the analogies of shape between sheets of flame and of liquids developed by concurring jets, which have been sug-

gested as indications of gaseous cohesion, it may be remarked that in both cases the form is doubtless due in great part to the composition of the oblique forces of the concurring jets, and that the resemblance is perhaps further increased by the resistance of the air, producing on the air-jet an effect in some degree the same as that of the mutual cohesion of the parts in the jet of liquid. Indeed if from such analogies of form we are to infer the control of cohesive force in streams of air, may we not with equal reason, in comparing the eddies and whirlpools of water with the dust-bearing spirals and huge gyrations of the air, ascribe to the latter a cohesive action like that which we know to operate in the corresponding liquid forms?

While thus expressing my dissent from such an application of Plateau's theory of liquid jets, and from any other view which would ascribe an effective cohesion to matter in the gaseous state, I gladly bear testimony to the clearness with which Prof. LeConte has presented his suggestions in its favor, as well as to the interest of other points in his paper.

ART. II.—*Enquiries concerning Stellar Occultations by the Moon and the Planets,—experiments upon Light and Magnitude in relation to Vision;* by Prof. A. C. TWINING.

IF, by the employment of any advanced means or modes of observation, or by any additional pains-taking, the occultations of fixed stars by the moon or the planets can be made more clearly and more frequently than at present a visibly determinate phenomenon, an important acquisition will be gained to astronomy. The illuminated discs of these occulting bodies, having an enormous area relatively to the minute stellar discs, overpower the latter at and near the place of contact, notwithstanding the difference of intensity in the two illuminations. Many orders of the telescopic stars are thereby excluded from this class of observations. How far the means which it is my present purpose to propose can be made available has not yet been determined instrumentally,—but they follow as a direct inference from the relative law of light and vision experimentally developed by myself, as will be shown before I have done. The means are so simple and obvious that, for years, and ever since they occurred to me, it has appeared surprising that something of the kind had not been employed at once, as soon as the equatorial movement came to be applied to telescopes. But the object of this paper includes, also, certain applications of the class of observations above mentioned, which do not appear hitherto to have been explicitly noticed. To these, in the outset, a brief attention will be given.

Occultations by planets available for determining the sun's horizontal parallax.

As, in the transits of Venus, a slow apparent motion of the planet, measurable by durations of the transit, is made, differentially, to express a minute change of parallax, so in occultations by the planets the periods of the star's disappearance may be employed in a parallel manner for the same purpose. But the latter phenomena—supposing them equally observable with the former—possess several remarkable advantages:—

First, In their greater frequency (if effectually brought within observation).

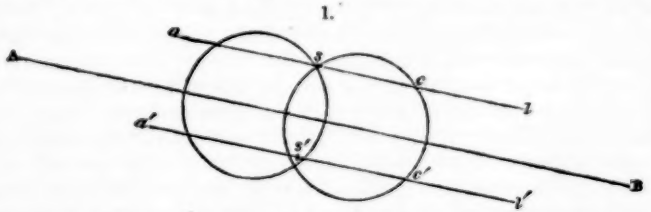
Second, In the probability that the phenomena may occur, at times, in a position of the planet near one of its stationary points, —so giving, by the slow apparent motion, an exquisitely *micrometric* measure of parallax.

Third, In a great change of duration becoming the measure of only a small lateral parallactic change in the line of the star's transit behind the planet.

On the other hand, it is true, we may have to meet the disadvantage of an increased distance from the object whose parallax is required,—also of a presumptive irregularity in the planet's outline,—and also of the possible existence of planetary atmospheres having no definite boundary.

In the following diagram let A B represent a portion of the planet's central path or orbit; $a\,b$ the apparent relative line of motion of the star s viewed from a terrestrial station, and $a'\,b'$ the similar path of the same star s' as seen from a station far north of the former (the planet's motion being from A to B).

1.



The two circles represent the planet's visible outline. The planet's mean angular diameter is supposed to be known by an average result of transits observed near and at measured approximate distances from its central path; and the ratio of its polar to its equatorial diameter is supposed to be given by the observed period of the planet's rotation;—we then compute the chords $s\,c$ and $s'\,c'$ from the observed periods of disappearance of s, and the sum (or difference) of the distances of those chords from the planet's visible centre becomes the measure of the parallax—a measure the more accurate according as the chord has a position the more nearly at its extreme from the centre.

Now, as an illustration and confirmation of remark "third" in the preceding paragraph, it will be observed that if Mars is the occulting planet it presents an instance in which parallax of a terrestrial base may be almost double the planet's angular diameter. Of course it will very commonly occur (and might in the majority of instances be made to occur by a suitable selection of stations) that the chords sc, $s'c'$ shall be thrown so far from the centre as to become small compared with the diameter, and shall therefore offer an unprecedented accuracy in the resulting parallax. If Venus were the planet the stellar transit as seen from one station might similarly occur (or be made to occur) nearly at an extreme position, but then, as seen from the other station it would generally be much more nearly central. If Jupiter were the planet it could only offer a striking advantage in case of fortuitous presentation of both chords in one and the same semicircle of the disc, and at or near an extreme distance of both from the centre.

Again, as an illustration and enforcement of the above "second" remark, it need only be observed that even so distant a planet as Jupiter, by its slow apparent motion when nearing or leaving its stationary points in the heavens, might show a great difference of times as the measure of a minute parallax. And this is equally true whether the terrestrial stations are so situated with respect to one another as to give a parallax, like that assumed in the diagram, normal to the planet's line of orbital motion, or situated relatively east and west in a manner to throw the parallax along that orbital line. Of the nearer planets, under a like favorable concurrence of circumstances, the same may be predicated (although, like the former, an extremely rare event) and with the farther advantage of a greater range of path through which the possible occurrence may be realized.

With respect to the above "first" remark, or that which relates to the frequency of occultations by the planets, I have found, since this article was commenced, a computed result by Dr. Winnecke, in the Astronomische Nachrichten, vol. 46, according to which it would appear that Saturn, with his rings, may be expected to occult some one star of not less than the ninth magnitude in each two years, on an average. Allowing this result we find by a rough computation that Jupiter ought similarly to occult a star once in each year, Mars over four times in each year, and Venus with a much greater frequency than either. But these numbers will be greatly reduced if restricted to occultations which shall admit of observation in the hemisphere from which the sun is absent. For the present object it is sufficient that these phenomena may be expected at such moderate intervals as to justify the labor of exploring the planetary paths in advance and bestowing extraordinary attention upon those stars

which may be occulted—they being generally individuals of the lower magnitudes that would otherwise remain undistinguished among the multitudes of their class. Moreover, such a planetary occultation, although but one of a century, *might* be more worthy of attention than any ordinary transit of Venus.

Mars, on account of its periodical presentation in the dark hemisphere for six months together,—its slow motions back and forward during that period,—and its favorable magnitude of disc, may not improbably obtain the preference, even over Venus in this mode of employment,—notwithstanding the far greater number of occultations, in a given time, by the latter. These remarks lead to the main topic of our enquiry, viz:—

The means of observing a small star in contact with an illuminated disc.

The object in this kind of observation not being distinctness of visible form or color but the mere disappearance and reappearance of stellar light, it is immaterial whether that light presents itself as a brilliant point or as a mere round nebula or haze. The spurious discs of several orders even of the fainter stars are believed to possess in the telescopic field a great intensity, compared with any focal image of a mere reflection—a planetary surface, for example. It is also a law of vision or of *perceptibility*—as will more definitely appear in the close of this paper—that a given quantity of light augments in perceptibility by expansion over an increased area or surface up to a certain degree of diffuseness, beyond which the perceptibility or effect upon the organs of vision rapidly diminishes. It is possible therefore by increase of magnifying power to pass the maximum of visibility for a fainter illumination long before that maximum is reached for a stronger. Not only so, but after the last named maximum is passed, the brighter illumination (according to the law hereafter deduced) fades, in its effect, much less rapidly than the weaker. In general therefore it may be presumed that any star whatever which is competent to exhibit a spurious—or rather a *focal* disc in the telescope (a disc expanded by irregularities of refraction) that exceeds very greatly in illumination the planetary disc in the same field is also competent to exhibit visibly the phenomena of disappearance and reappearance of the star behind the planet, even in contrast with the bright limb of the latter. In this proposition it is assumed however that the visible area of the planet shall be narrowed to the utmost practicable limit in the telescopic field,—in other words, that the telescopic field shall be covered at the focus by an opaque diaphragm perforated with a single opening made as narrow as allowable and centred upon the telescope's line of collimation. In this proposed darkening of reflecting surfaces there is nothing (the dia-

phragm perhaps excepted) but what has occurred in practice, but the question remains whether practice has distinctly recognized and carried to its limit the advantage obtainable in this way. My purpose herein is to fix attention strongly on the simple enquiry *whether immersions and emersions hitherto invisible may not be brought out to observation by narrowing an equatorially moving field to the utmost limit of the telescope's stability, and pushing magnifying power to an extreme.*

Effects of Planetary Atmospheres.

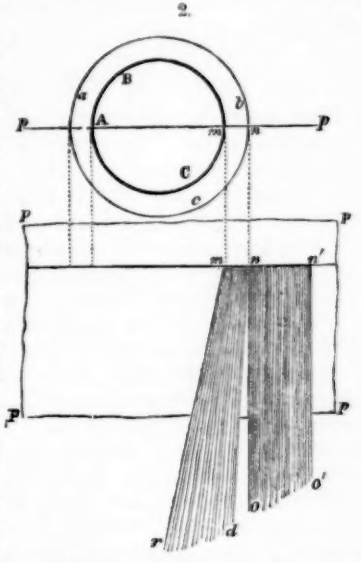
If the planet has an atmosphere it will obstruct our purpose vitally, unless that atmosphere has a definite boundary. Under the latter supposition, a star's disappearance, it may easily be proved, must be, for the moment, as complete and sudden as if the opaque body of the planet without an atmosphere extended out to that boundary. Indeed such a physical feature would afford the advantage of an even occulting line, in place of the more or less irregular outline of the planet's disc. It is true the star will reappear,—and its reappearance may very quickly follow the disappearance. But, however brief, if the interval can be perceived for an instant it is sufficient; and, on the other hand, even an excessively feeble refraction will give that sufficient instant. If however the atmosphere declines into space insensibly the star will move progressively outward from the planet, and fade away by a long gradation in which the eye can fasten upon no abrupt degree for the signal of observation. Thus, to an inhabitant of another planet who should observe an occultation by the earth, and with an eye capable of perceiving rays however faint, this progressive fading would continue for an entire day—or it might be, in some circumstances of the earth's apparent motion, for several days.*

But if the constitution of nature is such that material bodies are composed of atoms it must be true, apparently, that at a certain distance from a planet the stratum of atmosphere becomes of so feeble tension that the gravity of the atom must balance the repellency of the same. All the evidence therefore which applies to that supposed constitution of material masses supports the conclusion that the planetary atmospheres, where they exist, are, in fact, circumscribed definitely. The same conclusion is also supported by the common received evidence which, to some

* To some readers the following demonstration of these effects may appear requisite:—Let A B C be the outline of a planet's disc seen at the earth and having a star at n, just at the boundary of the planet's atmosphere, $a\,b\,c$. The planet's disc being normal to a ray from n to the observer's eye, pass a plane, $p\,p$, through the rays cutting the disc centrally in the line $A\,m\,n$, revolve this plane down and give it the position seen in $p\,p\,p\,p$. The rays in the broad beam, $n\,n'\,o\,o'$, are all parallel, and $n\,o$ is the ray to the observer's eye just antecedent to the instant of contact with the atmospheric boundary, $a\,b\,c$. But the very next ray, $n\,d$, is re-

extent, favors the idea of an existing atmospheric limit in the instance of our own planet.*

Thus our present enquiry opens a remote possibility of bringing astronomical observation to bear conclusively upon the most fundamental question respecting the constitution of material masses. It opens also a possibility much less remote of determining partially another point, and that of great interest in stellar astronomy,—I mean the actual angular magnitude of certain



fracted so as to leave a space, $d\,n\,o$, destitute of the star's light; and however small the angle of refraction it is sufficient at the great distance of the earth to create a dark interval and a consequent disappearance of the star. But let the planet move forward relatively to the earth the breadth of that interval and then let the ray, $n'\,o'$, touch the atmospheric boundary. Immediately the ray, $n'\,o'$, will be refracted in parallelism to $n\,d$ and so will reach the observer's eye. The star will therefore reappear; but it will be seen forward of its true position by the angular distance, $d\,n\,o$. Moreover as the planet moves onward, rays directed between $n\,d$ and $m\,r$ will come to view in succession—each fainter than what preceded, in consequence of being more dispersed by passing through the more and more dense atmosphere. In the supposed case of an occultation by the earth the last ray, $m\,r$, would be deflected more than an entire degree. It would reach an eye therefore at the surface of another planet only when the earth had advanced that amount in its apparent motion.

But if the atmosphere should extend indefinitely, there would be no angular break, $d\,n\,o$, and of course no disappearance. In this case even $n'\,o'$, and every other ray from $m\,r$ outward would be deflected, although less and less, until the deflection became imperceptible. And with the first perceptible advance of the star and progressively increasing dispersion of light its fading would commence, but would not be complete until the eye had received $m\,r$.

* In the only good opportunity ever improved by myself for watching the definite disappearance of the twilight, its boundary settled below the surface of Lake Erie with almost as much abruptness as the sun's limb, and at very nearly one hundred minutes after. I had changed place between the observations, but without change in the uncommon clearness and quiet of my horizon. The instant of disappearance was uncertain by no more than fifteen seconds; and even this could be explained by the gradual settling of the solar limb which was shining upon it.

It is the atmosphere *proper* that is here referred to. Upon the philosophy of atomic limits, there must be, it would appear, a secondary atmosphere of watery vapor having its own separate limit,—also an independent atmosphere of each constituent gas,—unless the latter subsist in chemical union with one another. In fact, since it is believed with good reason that the luminous condition of shooting stars is attributable to the intense condensation of gaseous matter collected in front by their rapid motion, it may be inferred that a medium of gaseous material exists at the greatest observed elevation of those meteors.

of the fixed stars,—and, consequently (in union with future parallactic determinations) their real magnitude. It is questionable whether Sir John Herschel's account of the insuperable difficulty of this determination will not be found to require a qualification.* The case, it is true, seems desperate so far as micrometric measurements are concerned: but the apparent motions of certain of the planets—indeed of all the planets in certain parts of their revolution—are so sluggish that $\frac{1}{100}''$ or even $\frac{1}{1000}''$ of arc would require an appreciable time for its description, and consequently for the total obscuration of a star of the like diameter. Moreover, suppose that upon rare occasions in the course of ages certain stars should present themselves upon any planetary outlines, within a few degrees of those points of the same whose tangents were parallel to the apparent orbital motion at the time:—then, for those particular stars, the angular diameter might become known by the observed duration of their fading.† But for this we need not go forward into the ages. Mars itself, once in every few years, will probably afford such an opportunity to any observer who is able to occupy a judiciously selected locality for the observation. Irregularities of outline (in the absence of an atmospheric limit) may, it is true, embarrass some of the results,—but not all of them, it is probable,—especially if observers at different neighboring localities improve the opportunity together. In a similar aspect of the case even the moon may become a useful auxiliary, through a like selection of localities, if by an antecedent preparatory study of the lunar outline (during eclipses especially) there can be found in the immediate vicinity of her poles any considerable extent of arc with an even contour, or even a small length, free from fissures, elevations, or other perceptible irregularities.‡

As already proposed I conclude, with some experimental results, obtained in April, 1847, which bear upon the foregoing discussion, and which had for their object:—

* "From the distance of the stars we are naturally led to the consideration of their real magnitudes. But here a difficulty arises, which, so far as we can judge of what optical instruments are capable of effecting, must always remain insuperable." —Outlines of Astronomy, Art. 816.

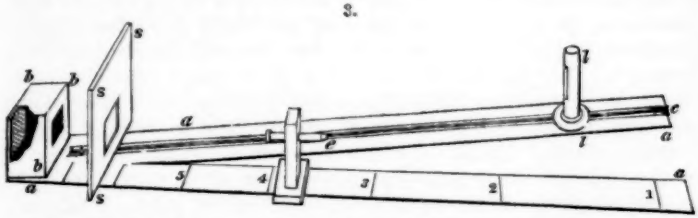
† To ascertain this duration, even approximately, might require the employment of an artificial focal disc both variable and measurable in brightness. Numerous comparisons with the star about to be occulted having denoted, upon the measuring index, a point of reference for equivalence with the star, the auxiliary disc, being set to a reduced but known degree of brightness, would give, by comparison with the fading star, one *epoch* of the observation, of which the other would be, the star's disappearance. The two together will afford data for computing the whole period of progressive disappearance.

‡ In this the entire absence of a lunar atmosphere is admitted. But the eclipse of Sept. 18th, 1838—which *just missed* being annular at New York—manifested, according to my observation, during more than two minutes of time, the distinct phenomenon of a thread of dense, *murky* light, completely around the non-eclipsing arc of the moon's limb.

The relations of illumination to magnifying power, when visibility is maintained.

A feebly illuminated area obliterates a point close to it, although of a much stronger light. We desire to know the laws which govern such an effect. Again, with the telescope, visibility depends both upon light and magnifying power. By increasing power we disperse light; and a true theory would determine from the data, under given circumstances, the arrangement proper for a maximum of penetrative power or visibility. My arrangements for the experiments above alluded to are figured below. They might be improved in almost every particular,—yet the indicated results, although with some evident latitude, appear to be unmistakeable.

3.



I prepared a frame, *aaaa*, with two branches. At the narrow extremity I placed a box, *bbb*, blackened within and without and having within on its back a paper regularly marked with small black round spots equidistant and regularly arranged (as seen through the broken side and top in the drawing). Light was thrown upon this paper through a square opening in the front of the box and a corresponding opening in the blackened screen, *sss*, so placed as to cut off the scattered rays in the room both from the paper and the eye of the observer. The source of light was the enveloped lamp, *ll*, which was moveable along a groove in that branch of the frame by a cord, *cc*, assisted by small friction sheaves. The other branch of *aaa* was graduated into distances increasing from the paper, in a geometrical progression, having the ratio $\frac{5}{4}$. On this branch there rested a fixed block carrying an eye-tube, *e*, of 0·16 in. circular aperture, and three inches long. This was directed to the paper seen through the openings in the box and the screen. The mode of proceeding was to fix the orifice *e* successively at the divisions of the progression, and, looking steadily through *e*, to move the lamp, *ll*, by the cord, *cc*, till the cluster of black spots became just resolved—or was just ceasing to be visible as a distinct cluster. The principal defect of this apparatus was a want of equable motion in the lamp, arising from the yielding of the cord and friction in the groove. The light would often move fitfully, not obeying the hand; and the eye would become fatigued before

the rectifications were well complete. Under the most favorable circumstances this species of observation is liable to large discrepancies,—however, a mean of many observations may give a reliable average. The observations made at each graduated distance were limited to four pairs. In the following table the first, or left hand, column contains the number of the observation or eye-station,—the second column gives in inches the distances of the eye at those stations from the paper,—the four columns following record the corresponding lamp distances, as observed. The seventh column contains averages of the four sets of observations,—and the last is a column of empirical distances computed for comparison, after the law of a common difference indicated by those averages. At the nearest station (and greatest corresponding lamp-distance) the faint illumination and consequent straining of the eye created occasional brief paroxysms of distinct and magnified vision which introduced uncertainty. These, in the then faint perceptive condition of the sight, may have been direct impressions of the imagination upon the retina,—or the mind may even have mistaken its own distinct conception of the visual object for a visual effect.

Tabular observations, April, 1847.

No. Stations.	Eye-distances.	Lamp distances.				Averages	Computed do.
1	134·11	14·5	14·8	18·2	14·5	15·5	14·8
2	107·29	34·3	29·5	27·6	26·4	29·5	30·8
3	85·83	40·5	51·7	50·6	46·5	47·3	46·8
4	68·66	57·4	69·2	61·9	64·7	63·3	62·8
5	54·93	74·9	77·1	74·7	79·1	76·5	78·8
6	43·95	99·0	90·5	88·3	90·2	92·0	94·8
7	35·16	114·1	106·5	110·0	111·4	110·5	110·8
8	28·12	138·4	122·6	132·1	133·4	131·6	126·8

It will be seen that this table, notwithstanding discrepancies arising from imperfect observations, decidedly indicates the following law as obtaining at the limit of distinct visibility,—at least for dark objects seen on a bright ground, viz.—that *while the distances of the eye diminish in a geometrical ratio the corresponding distances of the light increase in an arithmetical ratio.* In other words *the distance of the light is a logarithm of the linear magnifying effect.*

One remarkable result of this law is that a small fractional change of a faint light possesses as great efficacy to balance a given magnifying effect as a large fractional change of a much brighter light. Thus, in the above table, calling the brightest illumination unity, we have the illumination at the second station less than $\frac{1}{4}$. Here therefore over $\frac{3}{4}$ decrease of the light is required to balance a magnifying effect of $\frac{5}{4}$. But, in the next step, from the second to the third, the same power $\frac{5}{4}$ is balanced by a decrease of only about $\frac{5}{9}$ths of the light and, in the step from the last but one to the last, the same $\frac{5}{4}$ths of power is bal-

anced by less than $\frac{1}{4}$th the decrease of light. In this last case therefore the fraction of decrease is less than one-third the first. This exhibits an exact accordance with the following remark made in Sir John Herschel's Outlines of Astronomy, Art. 780,—and derived, I suppose, from a general comparison of the ordinarily accepted stellar magnitudes with photometric results,—"the eye (in the absence of disturbing causes) does actually discriminate with greater precision between the relative intensities of feeble lights than of bright ones, so that the fraction $\frac{3}{4}\frac{6}{0}$, for instance, expresses quite as great a step downwards (physiologically speaking) from the sixth magnitude [of stars] as $\frac{1}{4}$ does from the first."

Admitting, then, that this law holds equally as true for bright points seen upon a dark ground as for dark points seen upon a bright ground, it is easy to indicate the *principle* upon which the maximum visibility, attainable in given circumstances by increase of magnifying power, can be realized,—at least for distinct objects (as in the microscope), and for all focal images, except as affected in their distinctness by aberrations. For, in the above series, suppose the illumination at station 4, for example, to obtain in a telescopic field, and the view directed to circular dots of the same apparent magnitude as in that observation. Then suppose another eye-piece to increase the magnitude $\frac{5}{4}$, it will reduce the former illumination to $\frac{1}{2}\frac{6}{5}$. This is also, very closely, the diminution found from station 4 to station 5 in my experiments. Therefore visibility (at least when limiting distinctness is the question) is here at a maximum. If a third eye-piece were substituted, giving a second $\frac{5}{4}$ increase of dimension, the light would be a second time reduced $\frac{1}{2}\frac{6}{5}$, while the experiments show that visibility cannot be maintained with less than $\frac{2}{3}\frac{5}{6}$. This eye-piece therefore would be in defect of light by the ratio of unity to the fraction $\frac{9}{1}\frac{3}{0}\frac{5}{0}$.

The application most immediate to my object yet remains—and may be expressed, in substance, as follows:—suppose the illuminated ground, say of No. 4 in the table to be the disc of a planet, as viewed by an eye-piece, and the disc of a star to present a *contrast* of light much greater than that of the dark spots viewed in that experiment—yet not to be visible because not subtending a sufficient angular dimension. It follows that the field illumination, being at its maximum already, will be progressively darkened by successive augmentations of magnifying power; while, on the other hand, the stellar disc may advance toward visibility and finally acquire distinctness. Perhaps, in strictness, the total field of illumination should be considered angularly *constant* under all the changes of magnifying power, as that condition was probably an accident of the observations above tabulated,—although not recorded in my minutes,—nor am I certain that it is of essential import.

ART. III.—*Views and Suggestions on the Practice and Theory of Scientific Publication;* by Lieut. E. B. HUNT, Corps of Engineers, U. S. A.

IT is much to be regretted that physical investigators labor under so many and serious disqualifications for the successful prosecution of their researches. In addition to such hindrances as result from the stern necessity of procuring a livelihood, there are many others which do not seem necessary, and which still effectually obstruct that progress towards new truth by which the man of science measures success. Not least among these adverse circumstances is the almost universal fact that the man of science has not the command of those books, and special memoirs, in which are recorded the methods and results of anterior investigations. Except in the rare cases of conjunction between science and wealth, there is a perpetual inability to compare the research in hand, with the great body of related researches of the past and present times. It is scarcely possible that one's theme should be entirely his own property, and except in this rare case it is very needful that he should have habitual access to all records bearing on his particular line of research. Now this is utterly impossible, unless the investigator lives in convenient proximity to some one of the principal libraries. There is not yet in this country any single library at all equal to the entire demands of our whole body of investigators, and the two or three which are slowly approximating to this position of scientific catholicity are only very partially available beyond the charmed circle of an easy walk. In making a birds-eye examination of from 6000 to 7000 volumes of scientific memoirs and periodicals, &c., while gathering materials for an Index of References to be published by the Coast Survey, I have been more and more impressed with the vast affluence of the published wealth of science, and of the capacity of the many thousands of memoirs and articles passed in review, for a strict classification under specialities. It is entirely a safe assertion that no specialist, however restricted his speciality, is fully cognizant of all the published matter relating to his field:—and also, that without this full knowledge of labor and thought already expended, he must be wasting much of his own strength in doing again what others have completed. In point of fact, most of the active truth-seeking minds of this country are compelled to work on, remote from the chief central depositories of books and memoirs, happy if from their limited private resources they can secure as a private possession that carefully chosen minimum of special treatises which will give a starting point somewhere near the front line of actual research and discovery. Nearly all such isolated

effort is expended too much at a venture to bear the fruit of discovery to which it ought and is entitled to aspire. Not one in twenty of the members of this Association has the command of all those special records of research, which are needful to the symmetry and completeness of his own labors. There may be in the Astor Library a dozen closely related memoirs of which a specialist knows the existence, and a dozen more of which he has never heard, but if he must journey some thousands or hundreds of miles, at his own cost, to study them from 10 A. M. to 5 P. M., he is fortunate if he can use them on these conditions. The result is that only a few amongst us are able to do as we should, had we a complete library within easy reach. Such is nearly the universal truth concerning those who are by nature endowed with the faculties requisite for successful research. It cannot therefore be entirely profitless to consider what possible alleviations of this condition are practicable.

First then, it is a fixed tendency of scientific research, to subdivide during its progrees into numerous and well defined specialities. Each new branch of investigation soon subdivides into other and more limited branches, and though all are ultimately derived from one grand trunk, so vast that not even the giants of mind can span its circumference, still the special branches have a narrowness of diffusion which brings them quite within the compass of a single scientific mind. It thus happens that though many thousands of separate memoirs or investigations are preserved in the aggregate records of science, the pure specialist will find but few which are related to his own chosen field; so few indeed that could they be bought separately at the ordinary prices for printed matter, he might without harming his fortunes, possess as his own the essntial materials for a complete study of his speciality. If however he attempts this solution of his wants he is at once confronted with the fact that this small group of memoirs cannot possibly be purchased without buying in connection, the very costly series to which they severally belong. For the most part the series of scientific memoirs are grouped together without reference to subject, in a most illogical congeries, having only the date and the publishing society in common. Hence the specialist, when outside the limits of easy access to a complete library, must rely almost entirely on separately published special treatises for his knowledge of what has been done, and the original memoirs of the master minds must be forbidden treasures.

It is however obvious that such a lame condition of things is not one of original necessity, but has grown out of the history of scientific publications. If we go back to the times preceding the existence of Academies of Science, we find nothing answering to the scientific memoir. The Academies, formed from those

who were rich in ideas, but poor in purse, first found that by associating the limited wealth of a number, the great result otherwise denied, could be attained. When too they assumed an imposing exterior through the lustre of great names, the condescensions of patronage intervened, and the luxuries of type and engraving began to be lavished on the volumes in which their proceedings and choice memoirs were published. As science expanded its domains and augmented its small array of followers, academies sprang up in profusion and in ever increasing numbers, until now they have outrun the knowledge of even the most learned librarians. Nearly all academies have published or now publish volumes of memoirs which are the tokens of their vitality to all not within the chosen band. Wherever strong discovering minds have elaborated their researches the volumes of memoirs are enriched with treasures of close reasoning, sagacious insight, and results laboriously attained. These memoirs are still fresh with the vigor of original thinking, and cannot be spared, as part of the training of future discovering minds. When original memoirs give place in the studies of investigators to bald abstracts, feeble analyses, or popularized digestions, these investigators will grow sinewless, and discoveries, if made at all, will come despoiled of all their proper grandeur. We cannot too strongly deprecate the tendency even among specialists, to know the labors and investigations of original scientists only through abstracts and synopses, or general reports. These are indispensable aids for the knowledge of the immense related areas outside of one's speciality which he can only expect to know at second hand, and in the briefest method, but they are not among the legitimate means of advancing the boundaries of his own special field. Direct resort to original records is the prime condition on which the symmetrical and well furnished culture of specialists must rest.

In the true and philosophical sense of the word, most of the printed scientific memoirs cannot be said to have been published. Publication implies something more than mere printing. It involves the idea of circulation or diffusion among the whole group of kindred minds specially interested in the particular subject matter. A memoir on electro-magnetism, for instance, is not published when it is printed in the St. Petersburg Bulletin, because very few of those specially prosecuting electro-magnetic researches, habitually see this Bulletin. It is possible that nearly all of this class will see somewhere, a bald announcement that Lenz has after many experiments come to such and such conclusions; but this leaves them almost as much in the dark as before. Each memoir has its special public diffused over all lands where science is cultivated, and is only fully published, when it has reached the whole of this public. In some instances, this spe-

cial public would number less than a hundred, in some others it would be many thousands. To all not members of its own proper public, any special memoir is as an utterance of unknown tongues, and however much they may reverence they cannot duly appreciate it. If therefore a Society or Academy has procured the printing of a valuable memoir, it has the great matter of publication still left to attend to, so long as those specialists throughout the world for whom the memoir is really meant, are not duly supplied with printed copies. A memoir may nearly as well not exist, as to be printed and not properly circulated. As a matter of fact a large proportion of the most valuable printed memoirs have never been published at all. There is enough science buried in the documentary files of our general and state governments, to furnish out a long series of volumes. These scientific waifs are scattered broad-cast among politicians, and their constituents, but the humble devotee of science who spends years of labor in like researches, vainly strives to possess himself of a copy. In such cases, myriads of copies may be printed, and yet the memoirs are not published. On the other hand, if there be a special memoir on a subject which only ten men have studied or will study, the supplying each of these ten with a copy is a complete publication.

A great portion of the failure to publish printed memoirs is clearly consequent on the mode of publication. Nearly every academy prints its own proceedings and memoirs, aided by citizens whose local pride is enlisted in the promise of scientific distinction. With the printing however the matter is prone to end, there being no effective mode of publication. Scientific periodicals in like manner, though far more generally published than academic memoirs, are still limited to a small and inadequate circle of subscribers, and beyond this circle, they are in effect not published.

It will be evident on reflection, that the great desideratum for the correction of the evils indicated, is a *universal publishing agency* for all scientific memoirs printed by the societies, academies and periodicals of the entire scientific world. Without at all interfering with the formation of regular library files, by society donation or purchase, as is now done, such an agency would have enough to do in supplying all specialists with their special memoirs. The expansion of this idea into practical form would of course rest on the concurrence of all the societies, &c., which publish memoirs. I can perhaps most clearly indicate its workings by supposing the agency established; its system might be briefly this.

An agency is duly organized and guarantied to the world, by being placed under the control of a Board, or well established Institution or Society. The agent puts himself in correspond-

ence with all the societies which publish memoirs, and after fully explaining the objects of the agency makes arrangements with each Society to print a given number of separate copies of each memoir issued, making what might be called the specialists edition. The society might either furnish these copies at the cost of manufacture, or at a fixed price, or if it is able, it might donate them. Thus the universal agent will be supplied with unbound copies of each memoir. He is all this while supposed to be corresponding with all the specialists, for the purpose of ascertaining what class of memoirs each one may desire. He will soon be able to supply printed lists of titles, whereby each investigator can know what memoirs, just published, or announced as forth coming, he may desire. Thus a perfect understanding of the relation between supply and demand might be attained. This being all done and the agency fully supplied, Prof. A. B. living anywhere, orders a given number of particular memoirs at prices indicated in the list. He has only a limited surplus of means to bestow, but he can thus supply his exact wants at the minimum cost and without having to buy a large number of memoirs he does not want. The result will be that Prof. A. B. in a town remote from large libraries, can proceed in his chosen studies with all the aids needful for placing himself in advance of the known, and thus becoming an effective discoverer. The main object would be, not profit to the agency, but simply to give demand a free and full opportunity to call upon supply. As far as is now possible without reprints, the memoirs hitherto published would be included in the range of operations. An author publishing a special memoir in a periodical, by sending copies to such an agency would be sure of their going to the right persons. It is likely that many economical reprints might in time be justified. The main idea would however be to ensure the proper publication of new memoirs as they are printed. Such an agency ought not to be an ordinary commercial agency, without guarantee of its continuance, but it should rest on a firm basis, so as everywhere to deserve and possess confidence.

There are laws of political economy underlying the philosophy of publication which have been too little regarded in scientific issues. They have mostly been issued on the plan of large prices and small circulation. The right plan is a maximum circulation and a minimum paying price. There are enough ready to buy almost any special memoir to authorize its being sold at low prices. If however a large price is affixed it becomes at once prohibitory. Such publications as Taylor's Scientific Memoirs, and Liebig and Kopp's Reports ought not to be expected to succeed at such prohibitory prices as they bore. All that is necessary to ensure success to the principle of minimum paying

prices and maximum circulation is simply to organize the demands of scientists throughout the world so as to ensure to each specialist a chance of purchasing precisely what he wants, at fair rates. By doing this, scientific progress will be immensely stimulated and the poor barriers of cliques, nations, languages, and races will be swept away before the widely diffused liberalities of truly cosmopolite science. If the imperfect glimpses towards some vital generalities which I have now essayed, shall lead to a more correct appreciation of existing evils and to active reflection on the possible meliorations in the condition of the scientific body, my purpose will be fulfilled.

ART. IV.—*Chemical Analysis of Faröelite and some other Zeolites occurring in Nova Scotia;* by HENRY HOW, Prof. Chemistry and Nat. Hist., King's College, Windsor, Nova Scotia.

THE minerals described in the present communication were obtained from the trap rock of the Bay of Fundy, which is well known to mineralogists, particularly of America, as having yielded, especially at the point of land called Cape Blomidon and the region and the northern shore opposite, Partridge Island, a great number of beautiful zeolitic minerals. In excursions to another part of the same formation not so frequently visited, namely, the shore of Annapolis county, lying a few miles to the west of Blomidon, I met with some species, namely, faröelite, mesolite and epistilbite, which are not generally considered to occur in Nova Scotia, and indeed the first two, having somewhat recently been separated from others as true species, in Europe, have not I think been hitherto distinguished among the minerals of America. The analytical results now to be brought forward may possess an interest not only as indicating the existence of these minerals in North America, but also as strengthening their claims to the title of true species, which has been given them chiefly on the ground of chemical composition. In addition, an analysis is furnished of an unweathered specimen of laumonite, long known as occurring among the Acadian zeolites but met with only in certain districts of the Fundy shore affording them.

Faröelite.—This zeolite, which has long passed as a variety of scolecite, under the name of mesole, has recently been carefully studied by Dr. Heddle, of Edinburgh,* and the results of his investigations have led him to consider it a distinct species; he has accordingly named it anew, and in this I think he has done

* Edinb. New Phil. Journal, 1856, vol. iii, p. 351.

well, inasmuch as the designation he has chosen marks at once the individuality of the mineral and the locality affording him the material for the experiments upon which he has based his conclusions. The description given of its characteristic appearance and association is this:* "It occurs associated with mesolite but still always distinct from it, being in implanted and isolated globules or hemispheres sometimes overlaid but never underlaid by the mesolite. The color is usually bluish-white and the lustre decidedly pearly, not glassy like the mesolite."

I met with specimens having in every particular the foregoing characters, in the trap cliff in the neighborhood of a small fishing village called Port George, in Annapolis Co., N. S., and from having obtained some dozen specimens in the course of three or four hours' search for minerals, I have little doubt of its being tolerably abundant in that locality. The hardness of the mesole of Berzelius is stated to be 3·5, the specimens of the Nova Scotian mineral, whose analysis is given below, had hardness =4·5; very thin laminæ of it, which it afforded very easily, twisted before the blowpipe and in a good heat fused to a glassy enamel; it gelatinized perfectly with HCl before and after ignition. The analytical numbers I obtained are collated with those of Heddle from the Skye mineral; my first two analyses were on air-dry material, the third on that dried over HSO_4:—

	Scotland, Heddle.			Nova Scotia, How.		
	I.	II.	III.	I.	II.	III.
Soda,	5·77	4·38	5·33	5·00	3·75[a]	5·58
Lime,	11·54	11·40	9·82	11·70	11·92	11·52
Alumina,	28·44	30·00	29·30	29·31	29·98	29·52
Silica,	41·32	41·20	43·17	41·41	41·48	40·90
Water,	13·26	13·20	12·40	12·83	12·87	12·49
	100·33	100·18	100·02	100·25	100·00	100·01

[a] By deficiency.

It will be seen at once that the results are very concordant, and that we have the same combination in both cases. The oxygen ratio deduced for RO, R_2O_3, SiO_3, HO is very nearly $1 : 3 : 5 : \frac{8}{3}$ upon the average of the analyses, and Dr. Heddle writes as the formula of faröelite,

$$NaO\,SiO_3,\ 2CaO\,SiO_3 + 3Al_2O_3,\ 2SiO_3 + 8HO.$$

which requires the percentages,

Soda,	5·74
Lime,	10·37
Alumina,	28·57
Silica,	41·96
Water,	13·34
	100·00

* Fourth Supplement to Dana's Mineralogy, in Am. Jour. Sci., July, 1857, p. 118.

In the course of criticism Dana remarks,* "that the ratio of oxygen in Heddle's second analysis is rather $1:3:4\frac{1}{2}:2\frac{1}{2}$ (that of a hydrous nepheline) $=RO_2SiO_3+2Al_2O_3SiO_3+5HO$ (in which $2RO=\frac{2}{3}NaO+1\frac{1}{3}CaO$) = silica 40·25, alumina 29·83, lime 10·84, soda 6·00, water 13·08=100." My analyses would agree rather better with these percentages than with those of Heddle's formula; but still, as Dana says, "probably the preceding is the true ratio for the mineral," and, moreover, the recorded analyses† of nepheline do not give more than two per cent of lime.

Mesolite.—The mineral mentioned as the associate of faröelite, viz., mesolite, is very much the more abundant of the two, forming the larger proportion of specimens in which they occur together, and it is found not only in this association but filling per se cavities in the amygdaloid. It would also appear to be very frequent throughout the formation in the same neighborhood, and is sometimes met with in very large masses; I procured the remains of one, said by the owner, who gave it me, to have been found in a cavern on the shore since filled up, and to have been originally larger than a man's head; the piece I obtained was about the size of two fists, the crystals of which it was made up into a compact mass were from two to three inches long and translucent when separated, the specimen was homogeneous, or nearly so, having only a little stilbite attached to it, but was impressed with the form of a very large crystal of analcime; its analysis is No. I. below. Mesolite is said to be also very abundant on the North Mountains of Annapolis, some distance away from the shore; the form prevalent, from a specimen of my collecting being recognized there as very common by the owner of that last named, is an opaque white mineral in large masses of very close texture, having a finely fibrous radiated and penniform structure; this specimen furnished the results II. below. The third analysis is of a specimen found by myself at Port George; it was associated with faröelite in a reniform mass, and when broken up the fragments appeared nearly transparent and the aggregated crystals were prismatic.

	Dried at 212°.		Dried over H_2SO_4.	
	I.	II.	III.	Calculated.
Soda,	5·21	4·45[a]	5·68	5·29
Lime,	9·63	9·63	9·55	9·57
Alumina,	25·92	27·04	26·68	26·36
Silica,	46·84	46·48	46·71	46·46
Water,	12·11	12·40	11·42	12·30
	99·79	100·00	100·04	100·00

[a] By loss.

These results agree very well with the percentages placed in juxtaposition which are calculated from the formula

$$NaOSiO_3, 2CaOSiO_3+3(Al_2O_3SiO_3)+8HO,$$

* Loc. cit.

† Nicol's Mineralogy, p. 140.

given by Heddle* as that of "mesolite," and also by Berzelius† as representing the constitution of "lime-and-soda scolecite."

It is interesting to observe on comparing this formula, which includes those of two of scolecite and one of natrolite, with the formula of faröelite, that they differ in containing respectively three atoms of a monosilicate, and one atom of a sesquibasic silicate of alumina, combined with the same groups of elements, thus:

$$\left.\begin{matrix} 2(CaO\,SiO_3+Al_2O_3SiO_3+3HO \text{ scolecite}) \\ NaO\,SiO_3+Al_2O_3SiO_3+2HO \text{ natrolite}) \end{matrix}\right\} =$$

$$=NaO\,SiO_3, 2CaO\,SiO_3+3(Al_2O_3SiO_3)+8HO \text{ mesolite,}$$

$$NaO\,SiO_3, 2CaO\,SiO_3+3Al_2O_3, 2SiO_3+8HO \text{ faröelite,}$$

and I am inclined to think that, in the case of minerals occurring in such intimate association as these, when there is a choice of formula equally according with the results of analysis, that one is preferable which shows some such simple relation, and therefore that Heddle's formula is more probably the correct expression for faröelite than that of a hydrous nepheline before mentioned.

Epistilbite.—I found this species very generally accompanying a very fine variety of stilbite on ledges of trap at Margaretville, a village about seven miles east from Port George. The stilbite was in large transparent colorless broad columnar aggregates and the epistilbite in small reddish-colored rhombic crystals nearly or quite opaque. Although the former is by far the more plentiful the latter was present in considerable quantity on some specimens and on few that I collected was it altogether wanting; sometimes it appears to form the only lining in shallow cavities of the rock of this locality. A portion of the mineral detached from stilbite gave these results on analysis:—

NaO	KO	CaO	Al_2O_3	Fe_2O_3	SiO_3	HO
0·99	0·99	7·00	15·34	1·58	58·57	15·42=99·89

I met with the same substance on a specimen of honey-yellow stilbite in the cabinet of King's College, Windsor, N. S., among some minerals labelled "Nova Scotian," but the precise locality of this one was not marked: in this case it was so intimately mixed with calc-spar as to render mechanical separation impossible; its analysis which follows shows on this account some carbonate of lime,

NaO	KO	Al_2O_3[a]	SiO_3	CaO	CO_2	HO
2·02	*trace*	16·10	56·13	9·53	1·54	14·36=99·68

[a] With a little Fe_2O_3.

after deduction of this accidental ingredient the essentials become,

* Edinb. New Phil. Journ., iii, p. 351.

† Fourth Supp. to Dana's Min., loc. cit., p. 127.

NaO	CaO	Al_2O_3	SiO_3	HO
2·10	7·87	16·73	58·35	14·93=100·00

and the results agree very well with the preceding from the Margaretville mineral, and also with those of an analysis of an Iceland epistilbite by Kurlbaum, viz:—

NaO	KO	CaO	Al_2O_3	Fe_2O_3	SiO_3	HO
2·05	0·19	7·81	17·10	0·12	58·74	14·21=100·23

The formula for epistilbite given by Berzelius is

$$(RO\,SiO_3+Al_2O_3\,3SiO_3)+5HO,$$

and if RO=CaO the corresponding percentages are these,

CaO	Al_2O_3	SiO_3	HO
9·17	16·78	59·32	14·73=100.

The analyses recorded above would give for RO, $\frac{1}{4}NaO+\frac{3}{4}CaO$ leading to the formula

$$NaO\,SiO_3,\ 3CaO\,SiO_3+4(Al_2O_3\,3SiO_3)+20HO,$$

which requires the percentages,

NaO	CaO	Al_2O_3	SiO_3	HO
2·49	6·76	16·49	58·78	14·48=100.

Laumontite.—This mineral is very abundant at Port George, occasionally veins of three inches thickness are seen intersecting the sides of the cliff: a portion from the interior of a mass, gave these numbers, in the air-dry state—

CaO	Al_2O_3	SiO_3	HO
12·07	21·64	51·43	15·26=100·44,

which correspond well with the percentages,

CaO	Al_2O_3	SiO_3	HO
11·85	21·76	51·14	15·24=100,

calculated from the usual formula,

$$3CaO,\ 2SiO_3+3(Al_2O_3\,2SiO_3)+12HO.$$

The crystals agreed in all respects with the published descriptions. At Margaretville laumontite occurs colored green by copper.

ART. V.—*The Climate and Productions of Ponape or Ascension Island, one of the Carolines, in the Pacific Ocean;* by L. H. GULICK.

PONAPE, or Ascension Island, is situated in latitude 6° 55′ N., longitude 158° 25′ E. It is one of the five "high" islands of the Caroline range, in that part of Oceanica now so significantly called Micronesia. It is highly probable that Quirosa discovered it in 1595, on his way to Manilla from his unsuccessful attempt at colonizing on Santa Cruz. It is conjectured by M. de Freycinet that the Hogoleu group was that seen by Quirosa; but the description given is that of one large island of thirty leagues

circumference, which much more readily suggests the connected appearance of Ponape, than the random islets scattered in the immense lagoon of Hogoleu. As favoring this supposition I may mention M. Duperrey, as shown in his chart of the Caroline Islands (Hyd. Fr., No. 715, No. 33). It is only necessary to compare either Duperrey's or D'Urville's chart of Hogoleu, with Lutké's of Ponape; particularly the "views" of the two groups, as given on the margin of the charts.

There are several native traditions which render it certain that the island was seen by civilized voyagers during the seventeenth and eighteenth centuries, and during the first quarter of the nineteenth, without anything having been added to the vague discovery by Quirosa. Rear Admiral Lutké, of the Russian corvette La Seniavine, re-discovered Ponape, Jan. 2d, 1828. He remained in its vicinity three days, then proceeded westward adding more largely than any other individual to our knowledge of the Caroline range.

I have, as yet, been so unfortunate, in my extreme exclusion from "the world," as not to meet with the narrative of the Seniavine's voyage, and do not know how much, or what, may have been gleaned from this island by Kittlitz and the other members of the scientific corps of that expedition, and consequently have not been able to correct and assist myself by their reports.

There are two neighboring "low" or coral islands named *Aut* and *Pakin*, distant respectively ten miles southeast, and twenty northwest. They form, with Ponape, the Seniavine Islands.—I at present write only of Ponape.

It will be best to speak of Ponape as a group of basaltic islands, encircled by a coral reef seventy or eighty miles in circumference. A large island covers nearly the whole of the enclosed area, and is named Ponape, so giving name to the whole. Twelve or more basaltic islets, more or less distinct from the main island, add much to the scenery of certain parts of the group, and somewhat increase the area of habitable land.

Geography and Geology.

The following sketch of the island as seen from the east, is taken from the margin of Admiral Lutké's chart of Ponape.

M. Tenedos, N. 81°. La Guerite, N. 76°. N. 46°.

THE EAST SIDE OF PONAPE.

The height of what Lutké named Mt. Santo, is given by him as 2,858 feet. Several other points approach it in elevation. A somewhat continuous range of hills extends from *Uu* of the *Wa-*

neka tribe, westward to *Paleka*, of the *Jekoits* tribe. The terminations of the range are somewhat gradual slopes. The general line of the range is that of a curve, convex southward. The eastern third, or perhaps half, is narrow and almost equally precipitous on the northern and southern aspects, presenting in many places, as in *Uu*, perpendicular faces of rock of great height, that show strong columnar tendencies. The middle third of the range slopes very gradually on the southern aspect, where the mountains maintain a comparatively regular descent from their summits to the ocean shore, a distance of five or six miles. Several long narrow valleys run up these slopes, along the sides and at the heads of which are many faces of columnar rock, over which leap the most romantic of cascades. Again, the western portion of the range is narrow and precipitous.

A number of detached hills and short ranges still further diversify the scene, more particularly the following. Midway between the *Metalanim* harbor and *Aru* point, there rises a very high hill, of perhaps a thousand feet, which sends westward a low prolongation that connects it with the main central range. Again, on the north of the island, in the *Nut* tribe, there rises a similar mountain, but barely connected with even the mainland. At this place the most perfect basaltic columns are found. The central ridge of *Nut* is but a prismatic mass, and about its base lie scattered columns of great length, also detached piles of agglutinated columns. This must have been, I think, at least one of the spots whence the materials for the Metalanim "Ruins" were taken.

By the course of the main range and the positions of the subsidiary hills, two broad and long valleys are formed. One of them may be called the *Metalanim*, the other the *Nut* valley. Each of them may be four to five miles in width, and six to eight miles in length.

There are several solitary projections of rock in the Metalanim and Kiti tribes. One, much resembling a sugar-loaf in shape, in the Metalanim valley at the head of the harbor of the same name, is called *Takain*. Its height may be four hundred feet, and its circumference at the base three-quarters of a mile. Its eastern aspects are perpendicular; its western, not so steep but that by adhering with hands and feet, after the manner of the indigenous Gecko, it may be ascended. Adherent to the base of the main rock, yet separated from it above, is a much smaller rock. Within a quarter of a mile of Takain rises a dome-shaped hill, of almost the same elevation, but not so precipitous. (No. 19, 20.) At the head of the *Panian* harbor, a needle-shaped rock elevates itself from the top of a slight ridge. It may be ten or twelve rods at the base, and perhaps 150 feet high above the top of the ridge. On Lutké's chart it bears the

name *Mt. Guerite.* In the west end of the island is another needle rock, which I have never visited, much like *Mt. Guerite.*

A number of very active streams pour through the valleys on the southern side of the island. The largest is probably that emptying at the base of Takain. On the north of the central range there are no streams, save one or two draining the Nut valley. These streams, during the course of ages, must have effected great things. I question whether any bodies of water in the world are more active than these. During freshets, which occur with almost every heavy shower, they are deeply perturbed by the black and red earths with which they are laden. These alluvial substances are deposited along the shores, forming in many places immense flats, over which the tide ebbs and flows. It is only on the south side of the island, from the Metalanim harbor to Point Kittlitz, that these marshes are of any considerable extent, for on this side alone are the principal streams, and these southwest shores are protected from the roughened ocean acted upon by the northeast trades. The island at the mouth of the Nut valley is but one of the alluvial marshes.

The insulated basaltic points about the main island of Ponape are very interesting features of the group. *Mutōk*, or Mt. Tenenedos, as named by Lutké, is in reality an island, being only attached to the main land by an extensive alluvial marsh. It is a sort of double hill rising very precipitously on its eastern aspect 150 or 200 feet. *Jekoits* island is an irregular triangle, each side being perhaps a mile and a half. Along the eastern border, running north and south, is a high ridge 800 or 1000 feet in height, exceedingly precipitous. The northwestern part of the island is elevated from 150 to perhaps 250 or 300 feet and along its northern and western shores presents very precipitous ascents. The columnar tendency may be seen in most of the ledges of this island, though perfect prisms are rare. The Rev. Mr. Doane resides on the northern margin of the western portion of the island, upon the edge of the precipice, up which a tolerable path has been formed by taking advantage of this columnar arrangement and removing successive blocks. *Lungur* and *Poitik* are but points of columnar basalt, 100 feet or so in height with a talus about their bases, their circumference at the water's edge being perhaps half a mile. *Parum* is about a mile and a half in length, and in one place a half mile in width, with a central ridge that may be at points 300 feet in height. The *Mants* rise very abruptly from the water's edge. The smaller is a sort of dome, though presenting in many places faces of perpendicular basalt. About its eastern shore are considerable hillocks of coarse conglomerate. (Specimens Nos. 4, 5.) The larger Mant is but the crest of a ridge of prismatic rock

that along its whole western aspect presents a very precipitous face, and may be in one place 300 feet high. *Tapak* is but a repetition of the same, of less elevation. *Takain* rises with much of the usual perpendicularity to the height of perhaps 300 feet. The mass of its hill is of a reddish rock (No. 14). And in certain spots a red earth is found that makes an admirable paint for native canoes (No. 12); a substance that is also found in almost every part of the main island. *Mutokaloj* is about 50 feet in height, and is very small. Only on the margins of this islet have I succeeded in finding anything approaching to cellular lava (No. 8). *Taman* island has a general level of about 75 feet, and descends quite steeply to the water on nearly every side. Near it, to the south, are several very small and low basaltic islets.

It need scarcely be remarked that the general surface of all the basaltic members of the Ponape group is very rugged. Rocks and stones are scattered over almost the entire surface in the greatest profusion; and but few plains, even of a few acres in extent, are to be anywhere seen. The leeward slopes in the *Kiti* tribe present a few spots that may be termed level. Basaltic specimens may be found on almost every square rod of the island, but on certain spots they seem to be adventitious rather than native. In such spots the earth is a reddish clay, under which will usually be found what seems to be a decomposed rock (No. 11), with frequent seams of red earth (No. 12). Beneath the whole, we strike upon the substratum of basalt, in compact masses.

I send, accompanying, a number of *mineralogical specimens*, which I trust some one will describe for publication at the same time with what I write. I cannot but think that the very compact nature of all the island structures will be remarked with interest. Do not many of the specimens present almost the appearance of uninterrupted igneous rocks?

My principal object of geological inquiry has been for positive evidences of what I suppose may be specifically termed *volcanic action*, viz., the products of volcanoes and craters themselves. About the eastern shore of Mantapeti we find a conglomerate which I presume I am right in supposing attributable to volcanic action (Nos. 4, 5). So also at Shelong (No. 7). About Mutokaloj I find scoriaceous lava (No. 8). But as yet I have not been able to fix my eye on anything which in my ignorance I can recognize as a crater. Several of the hills have at a little distance, clothed as they are with luxuriant vegetation, that regular dome or cone-shaped contour which I suppose one feature or variety of isolated craters; but, on close inspection, faces of perpendicular basalt may almost always be found, which, with the absence of terminal bowls is I presume decisive against their

being craters. The Rev. Mr. Doane has called my attention to the appearance of the eastern terminus of the central range. The very end or point of the hills just as they reach the shore opposite to the *Mant* islands, seems as though removed by a gorge, leaving a semicircular area with steep sides, in some places 150 or 200 feet high. May this be a crater with one part of its periphery destroyed, or is it only an accidental termination? The certain detection of craters must be left for my future study, or for better instructed investigators.

Surrounding the whole body of basaltic elevations is a beautiful coral reef, distant from the coast of the main island the average distance of perhaps two miles. There are no less than seven considerable intervals in the continuity of this reef, forming as many harbors, several of which are really excellent ones. Between the reef and the shore of the island are all the usual coral patches that give such wondrous variety to tropic waters. The height of these patches varies greatly. A very considerable number of them are from an inch or two to a foot or more above the ebb tides at the syzygies. On the outer reef are a number of islets in every way similar to those on the purely coralline groups. They are found from the mouth of the Metalanim harbor, along the southern line, as far as point Kittlitz, but not on the north of Ponape. These islets have a nearly uniform elevation of about two feet above high-water mark. I gather from my own observations and from the reports of the pilots, that soundings are found outside of the reef, nearly if not quite round the island, at distances varying from a quarter to half a mile from the reef.

Mr. Hale, philologist of the U. S. Expl. Exped. under Com. Wilkes, has advanced the supposition that Ponape, in common with Kusaia (also called Ualan and Strong's Island), and other Caroline islands, has undergone a depression of several feet within a few centuries, that is, since the erection of the celebrated "Ruins" near the Metalanim harbor. (Report on Ethnography and Philology, p. 87.) Were Mr. Hale's suppositions regarding the original position of the Ruins on dry land correct, the evidence would be decisive of an important subsidence within a comparatively recent period. But I am well satisfied the structures maintain very nearly, if not exactly, the same relation to the ocean they did on their first erection. There is not, that I find, any evidence of accumulating sands about their bases, as would be the case had there been a subsidence. And again, the habits of the people would lead them to select just such a submerged position for the easier ingress and egress of their canoes, to which they are so attached as vehicles of travel. For a fuller exposition of my views on this subject I must refer to a paper on "The Ruins of Ponape." That Mr.

Hale should have suggested this hypothesis is not surprising considering the reports he had received. A personal inspection would, without a doubt, have influenced his mind as it has that of every intelligent observer. In my remarks on this topic I do not overlook the fact that the coral island regions are, in general, areas undergoing depression. The investigations of Mr. Darwin, with the further illustrations of Mr. Dana, are decisive on this point. I only question the supposition of any subsidence since the erection of those structures we denominate "the ruins." In this connection I may mention the tradition that there once existed a small islet at the mouth of the Metalanim harbor, to the north of the entrance, which had trees upon it, but which no longer exists, having been carried away by a great wave in the days of the grand-fathers of the present generation. Such little changes are continually taking place, one islet being formed at the expense of another. They are, I think, not at all indicative of subsidence. Earthquakes are unknown in Ponape.

Climate.

I first give a tabular view of meteorological observations. The decimals are the result of the observations having first been made with a "Centigrade" thermometer, and afterwards reduced to Fahrenheit. No one will fail to mark the astonishing uniformity of temperature. It may be doubted whether there exists a table exhibiting a greater. The mean daily range is about 10°; the mean difference of successive months a scarcely appreciable quantity; and the mean annual temperature 80·28°. The extremes during three years were 89° and 70°—a range of only 19°, and the lower limit was reached on only one extraordinary day, the 31st of March, 1853. Omitting the record of this day, the extremes are 87·98° and 73·76°, making the range but 12·78°, which is nearer the true average.

We may challenge the world to rival the uniformity presented in the following table, unless it be at other islands in this Micronesian Ocean. Surrounded by an immense expanse of water, and situated near the equator, the temperature could scarce be different.

The prevailing winds are "the trades" from the northeast. They blow most vigorously during the northern winter, while the sun, in southern declination, permits the farthest southern oscillation of the trade wind zone. During the summer, the trades retire to the north, leaving the island to "the variables." Yet, there is much difference between different seasons. There are times when the trades are light during the whole winter, but continue with great uniformity during the summer, as in the year 1856. The suggestion that there may be cycles in the operations of the trades seems not an improbable one. It is to be hoped that they may yet be studied out.

A Summary of the Meteorological Observations during 1853, '54, *and* '55, *on Ponape, by Mrs. Louisa Gulick.*

	Thermometric Conditions—Fah.							Udiometric Conditions.				Winds.		
	Mean at Sunrise.	Mean at Noon.	Mean at Sunset.	Mean.	Max.	Min.	Range.	Clear days.	Dys lig't showers.	Showery days.	Rainy days.	Days of Trade Winds.	Days of Var'bles	Calm days.
1853.														..
January, ..	78·00	85·00	82·00	81·50	88·00	75·00	13·00	15		10	6	..	..	..
February, .	76·00	84·00	81·50	80·33	86·00	73·00	13·00	6		8	14	..	..	..
March, ...	75·55	84·58	80·46	80·19	89·00	70·00	19·00	11		10	10	..	..	..
April, ...	75·41	83·86	80·10	79·55	86·00	71·00	15·00	6		17	7	..	..	..
May, ...	73·74	83·54	80·87	79·38	87·00	72·00	15·00	1		13	16	..	..	..
	m'n at 7 A.M.	m'n at 12 M.	m'n at 9 P.M.											
July, ...	76·95	82·73	78·09	79·25	86·54	75·00	10·54	2		11	7	..	..	..
August, ...	77·52	84·95	70·64	77·70	88·88	74·48	13·40	9		19	3	..	..	..
September,	77·36	84·50	79·70	80 52	88·52	75·20	13·32	14		13	3	..	..	..
October,...	77·66	83·11	79·09	80·02	87·44	75·20	12·24	11		17	3	16	15	..
November,	77·40	83·75	78·81	79·98	86·72	74·30	12·42	12		17	1	17	12	1
December,.	80·15	82·56	80·87	81·19	85·64	77·00	8·64	9		20	2	..	31	..
1854.														
January, ..	79·14	81·89	79·24	80·09	83·12	75·38	5·74	11	9	10	1	29	2	..
February, .	80·01	82·58	80·26	80·95	85·40	75·56	9·84	16		11	1	28	..	..
March, ...	79·26	82·83	80·54	80·87	86·90	75·56	11·34	11		18	2	23	8	..
April, ...	80·62	83·23	81·28	81·71	85·64	76·64	9·00	10	2	17	1	29	1	..
May, ...	80·57	83·16	80·92	81·55	86·72	75·20	11·52	4	2	23	2	29	2	..
June, ...	78·49	83·72	79·91	80·70	85·64	74·84	10·80	9	6	11	4	22	8	..
July, ...	78·24	79·49	75·46	77·73	86·00	75·20	10·80	9		20	2	11	11	9
August, ...	77·39	83·66	78·80	79·95	86·36	74·48	11·88	8	2	19	2	7	24	..
September,	77·36	83·30	79·34	80·00	86·00	74·48	11·52	10	4	14	2	11	16	3
October,...	77·90	84·38	79·16	80·48	86·36	75·74	10·62	12	12	6	1	6	10	14
November,	77·54	82·22	79·70	79·82	85·64	74·52	11·12	5	3	13	3	15	15	..
December,.	79·52	83·30	79·88	80·90	85·64	75·56	10·08	12	3	12	2	29	1	..
1855.														
January, ..	80·06	82·22	80·06	80·78	83·66	76·46	7·20	21	5	3	2	..	..	..
February, .	79·70	83·66	80·96	81·44	87·80	77·00	10·80	20		8	7	..	..	..
March, ...	78·80	81·50	78·44	79·58	83·48	73·76	9·72	11	2	8	9	..	..	..
April, ...	79·52	83·48	79·88	80·76	86·36	75·20	11·16	11	7	9	3	..	..	..
May, ...	78·44	83·30	80·06	80·93	86·90	75·56	10·34	12	2	8	8	..	..	..
June, ...	78·44	85·46	79·70	81·20	87·20	75·92	11·88	9	2	14	4	..	..	..
July, ...	77·36	83·12	79·16	79·88	86·36	74·48	11·88	4	5	20	1	..	..	..
August, ...	....	....	....	....	....	....	....	4	3	6		..	..	..
September,	77·72	84·02	78·98	80·24	87·98	75·20	12·78	10	3	15	1	6	24	
October,...	78·08	84·02	80·06	80·72	86·36	75·56	10·80	13	3	13	2	20	11	
November,	78·08	83·66	79·34	80·36	85·46	74·84	10·62	17		9	4	19	5	6
December,.	80·42	82·22	80·42	81·02	....	....	....	7		5		31	..	..
Average of 1853.	76·90	83·81	78·56	79·75	89·00	70·00	19·00	96		155	72	....	..	..
Average of 1854.	79·17	82·81	79·54	80·50	86·90	74·48	11·52	97	42	174	23	239	98	26
Average of 1855.	78·78	83·33	79·73	80·61	87·98	73·76	12·78	139	32	118	35	....	..	..
Average of Three years.	78·28	83·31	79·27	80·28	89·00	70·00	19·00							

Electric Conditions—1853.—*July*, thunder and lightning, 1 day; *Aug.* thunder, 1 day; *Oct.*, thunder, 6 days; *Dec.*, thunder and lightning, 4 days. 1854.—*March*, thunder, 1 day; *April*, thunder, 2 days; *May*, thunder and lightning, 1 day; *June*, thunder and lightning, 1 day; *July*, thunder, 2 days; *Aug.*, thunder, 1 day; *Sept.*, thunder and lightning, 1 day. 1855.—*March*, thunder, 1 day; *Aug.*, thunder, 1 day, and smokiness for several days; *Sept.*, thunder, 1 day; *Nov.*, thunder, 4 days.—Average of 1853, 12 days; of 1854, 8 days; of 1855, 7 days; of three years, 28 days.

The tornadoes or typhoons, so common among the strictly "South Sea" islands of the Pacific, and about the Bonin Islands to the north, may be said to be unknown here. Yet some of the very oldest inhabitants tell of a gale having swept the island during their early youth which destroyed the breadfruit and cocoanut trees so completely that a great famine ensued, by which a very large number perished. This was probably a "cyclone." And it is worthy of remark that the same thing is said to have occurred at nearly the same distance in the past, on Strongs Island, (lat. 5° 19′ N., long. 163°6′ E.), and with similar effects. It was probably the same cyclone that dealt destruction to both islands.

The humidity of this island is marked, yet equable. During the summer we are ever and anon covered by that cloud-zone which has been recognized as lying between the trade-wind zones, and which vibrates north and south with the sun and with the trades. The summer is our rainy season; yet situated as we are under the northern boundaries of the cloud-zone even during its farthest oscillations northward, we are by no means deluged with rain, as are many tropical localities. There are many intervals—sometimes of several weeks—of the most delightful weather during all the summer months. The trade-wind season, during the northern winter, is the driest portion of our year; but it never brings that parching heat which is the usual accompaniment of a "dry season." The trades reach us from their long ocean voyage, so deeply fraught with moisture that the impingement of their clouds on our hills of nearly 3000 feet, together with the slight reduction of temperature occasioned by the dense clothing of vegetation that completely envelops the island, secures oft repeated precipitations. And the island is of so small extent that the showers pass readily over to the leeward slopes, and water them equally with the windward. During the year 1856, when, as above noticed, the trades were light during their own appropriate season, yet intrusive during the whole summer, the island experienced a drought greater than any remembered by the oldest inhabitants. Yet even during that year the universal green was scarcely at all diminished. It may not be misplaced to call attention to this fact that the Northern Pacific generally participated in the meteorological perturbations that were so wide spread through all the northern hemisphere during 1856.

Thunder and lightning are rare and faint. It is a significant fact, that the natives have seen so little destruction by lightning that in the few instances which have occurred they never suspected its agency.

Plants.

Ponape is clothed with vegetation from its highest peaks quite into the ocean, and so dense is it that a passing vessel can

scarcely discern a house of the hundreds that are scattered along its entire circumference; and but for the smoke of domestic fires and the canoes gliding with magic sail and paddle within the encircling reef, the island might readily be thought uninhabited. The whole island is but an uninterrupted forest, with the exception of a few spots on the leeward slopes that are covered with a short coarse grass, whose green is of quite a yellow cast, and contrasts strongly with the intensely deep—almost black—green of the surrounding thickets. These grassy areas embrace from 3 or 4 to 50 or 100 acres. The soil of these spots is a very compact, reddish—almost ochreous—clay.

The growths of heavy timber are by no means confined to the dry land, but extend far out on to the coral flats, wherever the alluvial deposits before mentioned are lodged, there forming very extensive mangrove swamps, in which are found several kinds of trees, but principally varieties of the *Rhizophora*. These marine trees are themselves active agents in promoting the accumulation of alluvium, their numerous adventitious roots conservatively detaining the mobile particles. The area of these swamps is yearly extending; the intervening spaces between different patches, that form so many creek-like passages, being continually lessened; and the outer coral flats are becoming more and more green, particularly since the desolations by small pox in 1854, as fishing parties have much less actively and numerously trampled the flats to the prejudice of the rapidly germinating mangrove.

The luxury of vegetation gives a peculiar softness to the scenery of this otherwise rugged island. But the dead uniformity of its unbroken, sultry, green, must I think detract much from its romantic beauty, as compared with many tropical islands. Nor does the uniformity pertain only to color;—even the circumstances of varying height and form are apparently denied to the different tribes of trees, so completely does the mantling canopy of vines bind tree to tree, bridge every slight hiatus, and blend every peculiarity in one gently undulating flood. With the exception of two or three varieties of palms, that occasionally skirt the shore like the cocoanut, or stand in princely distinctness like the sago, the eye vainly seeks for something in form or altitude to relieve the luxurious scene.

There are several representatives of the family *Aroidæ*. Some of them in the damp forests run up to the height of trees, and send out branches, and may be climbed. The stems, or rather aerial portions of the root, of those that the natives name *Ot*, but whose scientific designations I cannot determine, make a very palatable and nutritious food, especially in times of scarcity. Several varieties of the *Arum esculentum* grow wild, and are occasionally eaten, but they are of an inferior quality, compared with

the *taro* of the Hawaiian Islands. Only one of them can deserve much attention, and this is very coarse grained and dry.

The natives distinguish no less than six varieties of *Saccharum*. I cannot give their scientific designations, if indeed they are all named. They are distinguished by the color of their cuticle, which is an index to the various degrees of compactness, juiciness, and sweetness of the interior. One variety, of a light yellow, I have been informed by an intelligent native of the Isle of France, is the same kind that makes the best sugar on that island. Good syrup has been made by the same individual on this island. With his rough and ill-adapted apparatus, one gallon of sap produced 1½ quarts of syrup.

The genus *Pandanus* is represented by at least two varieties. It is possible they should both be denominated *P. odoratissimus*, for it is true that the fruit, if not the male flowers, are very pleasingly fragrant. I should prefer however to call one of them *P. esculentus*. On this island, as on all the "low" islands of at least Eastern Micronesia (which comprises the Kingsmill, Radack, and Ralick Ranges,) the female spadices are highly esteemed, and even carefully preserved, as important articles of food. A large portion of each drupe is pulpy and sweet, and no doubt highly nutritious, and, to one accustomed to them, certainly quite as palatable as sugar cane. No one having visited Micronesia would remark of the *Pandanaceæ*:—"It can scarcely be said that the plants of this order are of any known use to man, except as furnishing, in common with many others, a good material for thatching." This variety of the *P. odoratissimus* which I term *esculentus*, grows alone on the sandy atolls. The leaves of both varieties, but particularly the upland, are used on this island for the construction of curiously plaited mats.

The *Dioscorea* (yam) is extensively cultivated. There are several indigenous varieties, some of which grow wild and are of indifferent eating, being very fibrous, while others are cultivated and are the finest of esculents. At least one variety of wild yam, eaten only in times of famine, needs from its bitterness to undergo a process of maceration to be made nutritious;—if this be not an exception, I do not know of there being any poisonous species of the *Dioscorea* on the island. A number of varieties of yam now found on the island are spoken of as foreign. The most of them have been introduced since ships began to visit the island; though some were brought from other groups of Micronesia by straying companies in their ship-like canoes.

The natives distinguish eight or ten varieties of *Cocos nucifera*, (cocoanut) depending on the character of the nut. The inside husk of the nut of one variety is considered sweet and edible by the natives, for which it is more valued than for the contained water and meat. The cocoanut thrives wherever planted

on every portion of the island; though the usual localities are along the shores and on the coral islets.

The leaves of what must I think be a species of the *Sagus* are used for thatching. It is usually found in quite moist localities. It stands perfectly erect and spreads its magnificent tuft at the maximum height of perhaps 75 feet. The surface of its fruit is broken into lozenge-shaped spaces which are so arranged as to remind one of scale armor. From a slight experiment it seems probable that sago can be procured from it.

A plant very nearly allied to the *Areca Catechu*, if it be not indeed the genuine betel-nut tree, is occasionally to be seen. The natives frequently chew the unprepared nut, but never combine it with lime and betel leaves, as in the East Indies, and as even on an island so near as Yap, lat. 9° 35′ N., long. 138° 8′ E.

A species of *Tacca* is scattered about the island, and might be made a considerable article of export. It is peculiarly abundant on the Aut Group.

The genus *Zingiber* has at least one representative here. Its root-stocks have much of the aromatic property peculiar to the genus, and are used by native practitioners for cataplasms.

Of the *Musa* (banana), there are many varieties;—neither Malabar nor Sumatra can boast of more; fifteen or twenty may be mentioned. The general remark will readily hold, that their fruits are not of the most delicate kinds, though the most of them can in various ways be so prepared as to be very palatable and important articles of even civilized diet, and at least two varieties will hold their place among the most luxurious of tropic fruits—specimens of the veritable *Musa paradisiaca*. I cannot certainly determine whether we have the particular plant of the Philippine Islands named *M. textilis*, but it is interesting, that several varieties here found produce a fibre that cannot be distinguished from the Manilla hemp. The natives have from time immemorial known how to prepare and variously dye this fibre, which they weave into very tasteful and durable belts, that are worn by the men bound about the body just over the umbilical region, above their cocoanut-leaf skirts. One variety, of which little care is taken, produces only abortive fruit, yet compensates for its sterility by furnishing what the natives deem an edible stem, quite tender and sweetish, and slightly nutritious.

At least one variety of the *Lauraceæ* is found here. It must, from its sensible properties, be a species of *Sassafras*, but I have no means of determining its specific designation. Considerable quantities of the bark of its stem have at different times been taken by traders to the Hongkong market.

The *Piper methysticum* grows luxuriantly, and is most assiduously cultivated. It sometimes runs up to the height of fifteen or twenty feet. The natives distinguish two varieties:—one

having a dark green stem spotted black, the other a very light green bark even yellowish. I think it is palpably less acrid and actively narcotic than the *P. methysticum* of Eastern Polynesia. The natives make most extravagant use of it as a narcotic beverage. The roots are pulverized, water added, and the juice expressed through fibres of the *hibiscus* bark. Some chiefs drink quarts of this daily, yet the only results are a temporary drowsiness that passes away after a doze of an hour or two, a diminished appetite, and sometimes a slight nausea and gentle retching. Nothing is ever seen of the peculiar desquamating effect upon the cuticle reported as the results of *ava-drinking* on the Hawaiian Islands. I conceive that the peculiar narcotic principle of the plant may be less concentrated in this humid climate than in the dryer regions of the Pacific Ocean.

The *Artocarpus*, (breadfruit) is the great food-producing genus to the inhabitants of Ponape. Without it they would starve, or be reduced to the dire necessity of slight labor for their sustenance; with it, no lords of creation are more independent. It forms most extensive groves, even forests. It is cultivated with all the little care it requires, and also grows wild over every portion of the island. The months of the northern summer are those during which the great harvest is gathered. There is another slighter crop in the winter or trade-wind season; and scattering trees may be found bearing during every month of the year. The crop is a somewhat uncertain one. The same trees seldom bear well two successive seasons; and an excess of moisture, as well as drought very sensibly affects it.—I have at hand nothing extended on this genus as studied where the species are more numerous than here; but I think the native classification of it interesting. They distinguish three principal divisions, which may perhaps be termed species, principally though not exclusively based upon the character of the fruit; a classification which I cannot but think more philosophical than that depending on the very accidental condition of integrity or incision of the leaf. 1. The *Mai mat;* that which is commonly called Jackfruit. The fruit of the *mai mat* is rough and very irregularly oval, and produces large seeds. The peculiar characteristic is that when ripe it can be eaten raw, its more delicate varieties being, to those accustomed to it, as palatable as custard. The leaves of some varieties are deeply lobed, of others not at all. It grows almost exclusively on the shady atolls of the outer reef; and it may be remarked that it is the *mai mat* that is found on all the coral islands of East, if not West, Micronesia. 2. The *Mai'n jarak.* The leaves of the greater number of varieties of this species are deeply incised, while some are most emphatically *integrifolia.* The fruit is usually prolately spheroid, and very symmetrical. One variety alone produces seeds. The

principal characteristic of this species is the roughness of the fruit occasioned by the pointing of the coherent sepals of each floweret. The number of distinguishable varieties of the *mai'n jarak* is astonishing. I have the names of over fifty! Nor are the marks of distinction merely fanciful. They are principally found in the peculiar qualities of the fruit. 3. The *Mai'n iwa.* Its leaves are both lacerated and perfect. The foliage and bark are less hirsute, and of a slightly lighter green than those of the *mai'n jarak.* The fruit is more spherical than that of the *mai'n jarak.* In the fruit of the *mai'n iwa* the flowerets are more closely blended, both interiorly and exteriorly, than in either of the other species. From this results an extreme smoothness of the rind, and a compactness of the fruit even to the very interior fibrous stem of the spike, that are characteristics strikingly different from the fruit of the *mai'n jarak,* where each floweret is not only distinct at its free extremity on the surface of the fruit, but also again at its base about the interior stem; and most especially different from the *mai mat,* where the degree of adhesion between the flowerets is at its minimum, there being scarce sufficient agglutination to connect the flowerets of a spadix into one point. The specific terms *incisa* and *integrifolia,* I would unhesitatingly reject. If the *mai'n jarak* be not already included in the species *Artocapus hirsuta,* (which I suppose not, from the two varieties of rough and smooth bread-fruited *A. incisa* being mentioned,) I would suggest that such names be given to the three species as shall designate the differing degrees of adhesion of the pistil-bearing flowerets.

The *Mangifera* has one representative, in a tree that bears a fruit certainly not unpalatable on an island so destitute of tart fruits, but which is quite fibrous, and not to be compared to the *Mango Indica.*

One plant of the genus *Citrus* grows wild. It bears a fruit about two and a half inches in diameter, which no one will be liable to confound with the *Pomme d'Adam.* Its rind is thick, quite aromatic when ripe, and very bitter. The interior is coarse, dry, and also somewhat bitter. I know not whether it be best designated as a *C. aurantium,* or *C. bigaradia.*

Animals.

There are only three species of indigenous *Mammalia.* 1. A small *dog,* not more than eighteen inches in height and proportionate length. Its hair is long and sleek, its ears short and erect. The posterior hairs of the tail as it curves upward are peculiarly long, which gives it quite a bushy appearance. It is a sprightly but unintellectual variety, worth little save as a companion and as food for a degraded race of men, and as furnishing retreats for the lice their masters deem such a delicacy.

2. *Rats.* The variety here found is a peculiarly disgusting kind, and is very numerously represented. They are very destructive in gardens, rooting up the seeds of all leguminous plants, and even devouring young chickens and attacking setting hens. 3. *Bats.* The natives distinguish two varieties, a large and a small; but I am not satisfied that the cause of difference is anything but age. The largest individuals will measure eighteen inches from tip to tip.—*Whales* and *porpoises*, are comparatively numerous in the surrounding seas.

Of *Birds* there are twenty-nine or thirty species. They are distributed *probably* in the following proportions among the different orders, as clsssified by Swainson. 1. Of the *Raptores*, one species, a small *owl*. 2. Of *Insessores*, fourteen or fifteen species. The Dentirostral species number eleven or twelve. I do not know of any Conirostral, or Tenuirostral. There are two Fissirostral, a *kingfisher* and a *nightjar;* and one Scansorial, a small *parrot*. 3. Of the Natatores there are six species; one that may be a *sea-duck*, the rest *gulls*, one of which is the *Phæton*. 4. Of the Grallatores, one *plover*, one *sand-piper*. 5. Of the Rasores, two *Columbidæ*, the *Ptilinopus cyanovirens*, and the *Carpophaga oceanica;* and a small partially domesticated *fowl*.

The number of individual *Reptiles* is great, though confined to a few species. At least two species of turtles are found in our waters, the *Chelonia mydas* and *C. imbricata*. They visit the uninhabited Aut Group to deposit their eggs. The so-called "tortoise-shell" forms an export of some value. There are several species of the *Lacerta* group, and these constitute the main body of the island Reptilia. We have one variety of what I suppose may be an *Iguana;* and also a *Gecko*.

I need scarcely remark that the varieties of *Fishes* are very numerous;—and more than this I will not attempt to report. A fresh-water *eel* is an object of great veneration and fear. A species of harmless *shark* is very abundant. A large *sting-ray*, (probably a *Trygon*,) frequents the coral flats and is the occasion of much fear to wading fishermen.

Insects are somewhat numerous, but are probably distributed through a comparatively small number of genera. I think the remark will hold that the orders Coleoptera, Hemiptera, Orthoptera, Homoptera, Neuroptera, and Lepidoptera, in particular, are not numerously represented. *Cockroaches* and *dragon-flies* are the largest insects we have. One species of small *white ant*, is a source of some trouble. There are six or more kinds of true *ants*, that are not however of the more intrusive and destructive kinds. The cosmopolitan *house-flies* and *fleas* are found, but are not troublesomely numerous. *Musquitoes* are bred by myriads in our swamps.

Of the *Arachnida* I can only say—that a few varieties of *spiders* are found, and among them there is one whose feet when extended cover a surface of three inches diameter; and that a small *scorpion* is occasionally seen, though not at all feared.

The *Crustacea* and *Mollusca* are numerous and attractive, but it is little I can as yet report concerning them. Without having done more than induce the natives to collect for me, I have on my shelves about a hundred species of shells. A small *squid* is eaten by the natives. One species of *Nautilus* is drifted ashore, always in a mutilated condition. The natives suppose it to be a fallen star! I am surprised that as yet I have discovered but six or seven of the terrestrial Pulmonifera, a group very abundantly represented at the Hawaian Islands. Of the Conchifera I have fifteen or twenty species.

Of the *Radiata* I only know that our waters are alive with them. Twelve or fifteen species of the *Holothuria* are found, though the varieties most valued in China are comparatively scarce. *Biche de mer* has several times been cured here by foreigners for the Hongkong market.

ART. VI.—*Contributions to Analytical Chemistry;* by HENRY WURTZ, of New York City.

On the Detection of Nitric Acid in solution, with Observations on the Action of Sesquisalts of Iron upon Indigo and Metallic Gold, and on the Neutralization of the Colors of Metallic Solutions.

(Read, with experimental illustrations, before the American Association for the Advancement of Science at Baltimore, 1858.)

IN the course of an investigation now in progress, the first part of which has already been presented, I have had constant occasion for a good practical method of determining with certainty the presence or absence of nitric acid in small quantities under all possible conditions. The different methods that have been devised for the accomplishment of this important qualitative operation were therefore submitted to examination, and the results obtained seem worthy of being presented in a collected form. The following are the most important of these methods.

1. The *protosulphate of iron test*, or method of Richemont. This depends upon the well-known reddish or purplish-brown color produced by the combination of the nitric oxyd formed by the deoxydation of free nitric acid by proto-compounds of iron, with the excess of the iron compound. H. Rose, in the last edition of his Handbuch,* ranks this test above all the

* I, 659.

others, and certainly, when manipulated as there directed by Rose, Richemont's test is scarcely surpassed in delicacy by any other; and when the liquid to be tested is colorless, it is extremely convenient; but unfortunately the color produced has too little about it that is *characteristic*, and is therefore not certainly recognizable in the presence of many other colors that are of very frequent occurrence. When the quantity of nitric acid is minute, this test requires also a very considerable *length of time*, an important objection.

2. The *iodine test*, or method of Higgin,* dependent upon the setting free of the iodine of iodid of potassium by free nitric acid, and formation of the blue starch compound. When no other free acid than the nitric is present, this mode may be made very delicate and reliable, but when in combination, the nitric must be set free by the addition of sulphuric acid, and as Gay-Lussac long ago observed, sulphuric acid alone gives with a solution of iodohydric acid, or, which is the same thing, with iodid of potassium, free iodine, by the following reaction, $SO^3+HI=SO^2+HO+I$.† Even in dilute solutions this appears to take place after a time, and when but traces are to be tested for, it is difficult to be certain whether the free iodine indicated is due to nitric acid or to this reaction. With great care, however, I believe that this method may in some cases be made useful, particularly when *free* nitric acid is to be tested for.

In the presence of the least trace of a *sesquisalt of iron*, this method is especially fallacious, a fact which has I believe heretofore escaped attention. I find that a deep blue color is immediately produced when but a minute trace of any such compound is present. In fact, the conclusion that I have drawn from experiment is that a mixture of iodid of potassium and starch solutions when used as a test for sesquioxyd of iron in solution, yields in delicacy and sensitiveness to no other mode now in use, and I wish therefore to propose it as a new method of detecting the presence of small quantities of iron. The reaction takes place both in neutral and acid solutions; with sesquichlorid of iron it is of course as follows,

$$Fe^2Cl^3+KI=2FeCl+KCl+I.$$

3. *Schœffer's test;* presented to this Association by G. C. Schæffer at the New Haven meeting in 1851.‡ It depends upon the conversion of the nitric into *nitrous acid* by the action of metallic lead, and then treating with yellow prussiate of potash and acetic acid, when a deep golden yellow color is developed. This test is extremely delicate, indicating, according to Schæffer, the presence of saltpetre in 60,000 parts of water. As however

* Chem. Gazette for 1850, p. 249. † Gmelin's Handbuch, I, 689.
‡ Am. Jour. Sci., [2], xiii, 117; Liebig und Kopp's Jahresbericht für 1851, 625.

the nature of the yellow compound formed is not precisely known, much less the character of the reaction that takes place, we have no data from which to infer how the presence of other substances, particularly of metallic salts, would modify the result, and I should accordingly hesitate to rely upon it without much previous investigation.

E. W. Davy has since given a somewhat similar process,* dependent on the formation of a *nitroprussid* by heating with yellow prussiate and chlorohydric acid, adding an alkaline carbonate when cold, and then sulphid of ammonium to the filtrate, to produce the familiar brilliant purple color, by which he detected the 200th part of a grain of saltpetre. It is desirable that this beautiful method should be fully examined, and the modifying influences of all other substances determined, a work which would require much time and labor.

4. The *brucine test.* This depends on the deep blood-red color given by brucine in contact with free nitric acid, and is lauded as extremely sensitive by Fresenius in his last edition.† It is necessary to success, however, that the nitric acid should be in a certain state of concentration.

5. The *gold test;* founded upon the power of mixtures of nitrates with chlorohydric acid to dissolve *gold leaf,* by virtue of the chlorine set free, the gold being afterwards detected in the solution by protochlorid of tin.

An observation of a very surprising and unexpected character made in connection with this mode of testing may be appropriately introduced here. I found that solutions containing sesquioxyd of iron (no nitric acid whatever being present) have the power to dissolve gold. A solution of pure sublimed sesquichlorid of iron was boiled with a fragment of gold leaf. The liquid soon became turbid, from deposition of a basic chlorid, as is always the case with neutral solutions of ferric salts, but on acidulating with chlorohydric acid, it cleared up and the gold had disappeared. Another fragment also dissolved, and so on. The action is accompanied by the production of protochlorid of iron, as is easily shown by a solution of ferridcyanid. On filtration, dilution, and treatment with sulphohydric acid, the precipitate obtained in the liquid had quite a dark brown color, and when washed, dried and burned on platinum foil, left a residue easily proved to be spongy gold by burnishing in an agate mortar.

A solution of pure ferric sulphate was also proved to dissolve a little gold, though less readily than the sesquichlorid, and to be reduced to ferrous sulphate. Even at the ordinary tempera-

* Lieb. and Kopp's Jahresb., 1853, p. 654.

† "Diese Reaction ist ungemein empfindlich." Fresenius's Anleitung zur qualitativen chemischen Analyse, Braunschweig, 1856, p. 175.

ture a solution of the sesquichlorid, standing for several days in contact with gold leaf, gave a green tinge with the red prussiate, indicating reduction. An acid solution of the sesquichlorid is also partially reduced by digestion for a few hours on the sand-bath with clippings of *platinum* foil. The solutions of gold are not affected by refrigeration, concentration, dilution or filtration.

I cannot find that this action of gold and platinum upon ferric solutions has been announced before. If observed, it may have been attributed to traces of nitric acid or chlorine still remaining in the liquid, a cause of fallacy not existing when the sublimed sesquichlorid is experimented with. Metallic silver, however, has been observed to reduce ferric salts. Gmelin says, "metallic silver takes up oxygen from a boiling aqueous solution of the sulphate of sesquioxyd of iron so that sulphate of silver and sulphate of protoxyd of iron are formed; in the cold, metallic silver precipitates again and the solution contains only sulphate of sesquioxyd of iron as before."*

It is evident that this behavior of gold vitiates entirely the gold test for nitric acid in the presence of iron.

6. The *indigo test.* This familiar method needs no description. When chlorohydric acid (or chlorid of sodium, as recommended by Liebig†) is added, the bleaching is undoubtedly due to the production of free chlorine, just as the solution of gold under the same circumstances was proved to be by Gay-Lussac.‡

All the five methods previously mentioned depend evidently upon the *production* of a color not previously existing in the liquid, and which in many cases may be produced by the presence of other substances besides nitric acid, whilst the indigo test depends upon the *destruction* of a color previously existing, this color being at the same time a very characteristic one, seldom found in solutions, and belonging to a very stable compound that is well known to be affected only by the most potent oxydizing agents. It seemed to my mind therefore that, other things being equal, the indigo test possesses elements of greater certainty than the others, and furnishes stronger *positive* evidence of the *presence* of nitric acid, though some others may give stronger proof of its *absence.* I set myself at work therefore to investigate the indigo test, and ascertain the circumstances which can modify its action.

I quickly discovered, as announced in a former paper, with surprise I must admit, that like the gold test, it is wholly fallacious in the presence of compounds of *iron.* A solution of pure neutral sesquichlorid of iron was found to bleach indigo powerfully, with formation of protochlorid. The iron solution used was freshly prepared from green crystals of the sublimed ses-

* Gmelin's Handbuch, i, 128. † See H. Rose's Handbuch, last edition, i, 664.
‡ Liebig and Kopp's Jahresb., 1847-8, 389.

quichlorid.* Excess of chlorohydric acid does not affect the result. A solution of pure ferric sulphate made by evaporating the sublimed sesquichlorid with excess of pure sulphuric acid until free from chlorine, also bleached indigo powerfully; and when a small excess of indigo was added so that the liquid had a perceptibly bluish tint after long boiling and cooling, crystals of pure chlorid of sodium being added produced no further change after renewed ebullition, thus showing that the bleaching power of the sesquisulphate is little, if any, inferior to that of the sesquichlorid. Red prussiate indicated also in this case a reduction to ferrous sulphate.†

When iron then is present in a liquid to be tested by indigo, it is necessary to precipitate it first, and test in the filtrate after addition of excess of acid. For this precipitation I have recommended in a previous paper the use of *ammonia*, but since that was written the idea has occurred that the presence of ammoniacal salts may possibly interfere in some way with the reaction, although it may be difficult to understand how. An experiment however, in which two parallel trials were made, everything else being equal, but in the one case a large quantity of sal-ammoniac (free from iron) added, seemed in its result to justify this apprehension. It is *safer,* therefore, until this point is more distinctly determined, to precipitate the iron in every case with *carbonate of soda.* And when ammoniacal salts are already present the ammonia may easily be expelled by evaporation with excess of carbonate of soda before testing.

Besides ferric solutions, the following substances were found to have the power of bleaching indigo.

Terchlorid of gold, after evaporation to dryness with a large excess of chlorohydric acid, to remove all possible traces of nitric acid, gave a solution which bleached indigo very largely when boiled with it, gold being reduced and deposited, partly as a metallic mirror upon the sides, and partly as a black powder at the bottom, of the test tube. When boiled with a large excess of indigo so as to remain still blue, then filtered and the blue color destroyed by nitric acid, the liquid was not affected by sulphohydric acid, and no longer contained therefore any gold.

Bichlorid of platinum, freed in the same way from all nitric acid, bleached indigo powerfully, with production of a very deep

* It was observed that such a solution, after exposure to the *light* for some weeks contained traces of protochlorid, confirming an observation of Osann to the same effect (Lieb. and Kopp's Jahresb., 1855, p. 406). Such a solution must therefore be kept in the dark. I may remark here also that it is advisable not to *filter* such a solution through paper, as it was found, after standing for a short time in contact with purified filter paper to give a green color with the red prussiate.

† It may be added here that some other vegetable colors were tried, such as acid solutions of litmus, logwood and cochineal, and found to be likewise readily decolorized by sesquichlorid of iron.

brown color (protochlorid of platinum) no precipitate being formed.

Bichlorid of tin, made by passing chlorine gas through a solution of the protochlorid to saturation, adding some chlorohydric acid, evaporating to dryness and heating the residue until it volatilized strongly in white fumes, to expel all excess of chlorine; gave a solution which bleached indigo readily and copiously even *in the cold*. Acidulation with chlorohydric acid did not affect the action.

Pure *arsenic acid*, having been evaporated in solution twice with chlorohydric acid to ensure absence of nitric acid, left a crystalline residue which still contained much arsenic acid, for its solution gave with nitrate of silver the brick-colored precipitate, but which apparently retained also chlorohydric acid in some form of combination. On boiling the aqueous solution of the residue with indigo solution no bleaching action could at first be obtained, but on addition of a little chlorohydric acid the blue color, though slowly and with some difficulty, vanished.

It is scarcely necessary to remark that all substances which evolve chlorine, iodine or bromine, with muriatic acid, will also bleach indigo, such as KO^3, BaO^2, Ce^2O^3, the *chromates*, the *deutoxyd* and salts of the *sesquioxyd of manganese*, *manganates* and *permanganates*, *chlorates*, *perchlorates*, *iodates*, *bromates*, *deutoxyd of lead* and the *sesquioxyds of nickel* and *cobalt*.

A mixture of deutoxyd of manganese with dilute sulphuric acid bleaches very strongly.

There are a few other substances which interfere, although in another way, with the reaction. These are those bases which give precipitates with the sulphuric acid of the indigo solution, such as *baryta*, *strontia*, *lime*, and *oxyd of lead*. Such precipitates, by making the liquid milky, render the change of color during the bleaching less discernible; and moreover, it was found that the indigo, being insoluble in other acids, all goes down with the insoluble sulphate, so that the filtered liquid is colorless. These bases are readily removed; however, at the same time as the iron, by precipitation with carbonate of soda and filtration, before applying the test.

I now come to a class of difficulties which at first sight seemed less easy to obviate. These are the cases in which the *color* of the liquid to be tested approaches more or less to that of the indigo solution itself. This occurs with solutions of *cobalt*, *nickel*, *copper*, *chromium* and *uranium*. The mode devised for overcoming this was perfectly successful in every case. It consists of an expansion of the happy idea of Dr. Gibbs (founded upon an observation of Mauméné*) in applying Crum's test for manganese to cobalt and nickel solutions, and has been repeatedly alluded

* Liebig and Kopp's Jahresbericht für 1850, 156.

to in a former paper. Some further details, however, of a special character are necessary here.

The chlorids of cobalt and nickel are used reciprocally, after the manner of Dr. Gibbs, to neutralize the colors of each other. The color of the mixture, as I have obtained it, is when concentrated rather *grayish* than *brownish* as it is designated by Dr. Gibbs.* This slight residual color is however of no consequence, as all that is necessary is to get rid of all admixture of *blue* tint, before adding the indigo solution. In working with cobalt solutions it must be carefully borne in mind that the ordinary rose colored hydrate of chlorid of cobalt is converted *in solution* into the blue anhydrous chlorid by admixture with strong chlorohydric acid, or even with the dilute acid on heating, so that in the application of the indigo test to a mixture of chlorids of cobalt and nickel, on heating to effect the bleaching, the liquid usually assumes a blue color deeper than it had before. If nitric acid is present, however, on cooling the hot mixture by addition of a little cold water, or better by a current of cold water on the outside of the test tube, the blue color wholly disappears.

The green colors of solutions of copper, chromium, and uranium are neutralized in the same manner as solutions of nickel, with chlorid of cobalt. In the case of copper it must be remembered that, as Gladstone has shown,† chlorid of copper, like chlorid of cobalt, differs in color according to the quantity of water it is combined with, being in dilute solutions *blue*, but on admixture with strong muriatic acid or on heating, assuming a peculiar *greenish* tint. Now it is only the *green* chlorid which neutralizes the chlorid of cobalt, so that it is necessary to have sufficient muriatic acid present to ensure the existence of the copper salt in the green modification, at least while the liquid is *hot*. The color produced is then very similar to that obtained with the chlorids of cobalt and nickel. In the green-yellow solution of chlorohydrate of uranic acid, the green tint is perfectly obliterated by chlorid of cobalt, a light *salmon* tinge being produced which does not interfere with the indigo test. A solution of chlorid of chromium is precisely similar in its action to one of chlorid of nickel, the resultant color with chlorid of cobalt being *identical* in appearance. A concentrated green solution of

* The chlorid of cobalt used was chemically pure, having been prepared by the elegant method recommended by Gibbs and Genth in their late "Researches on Ammonia-cobalt bases," (Am. Jour. Science, [2], xxiii, 260,) which consists in igniting the violet crystals of the *chlorohydrate of purpureocobalt*, dissolving the residual mixture of chlorid and sesquioxyd of cobalt in dilute muriatic acid and expelling the excess of the latter by evaporation. The solution has an extremely rich rose color. The chlorid of nickel used was also prepared with care, and was of high purity.

† Lieb. and Kopp's Jahresb. 1855, 414.

protochlorid of iron is also rendered almost completely colorless by a little chlorid of cobalt, but this is of course a matter of no importance in connection with the indigo test.*

In conclusion, to describe the general *mode of manipulation* which I adopt, having found it to add materially to the delicacy and reliability of the test. The liquid to be examined is treated,

* A few other observations were made upon the effects of mingling colored solutions. The nitrates of cobalt and nickel when mixed in proper proportions neutralize each other just as the chlorids do. With the chlorid of nickel and the nitrate of cobalt the neutralization is probably more perfect than when the two chlorids are used. With chlorid of cobalt and nitrate of nickel the resultant color was rather brownish than grayish. The nitrates of copper and cobalt did not seem to be entirely complementary, for on gradually mixing their solutions, the red color of the excess of the cobalt compound began to appear before the blue of the copper solution had entirely vanished, giving a violet tinge to the mixture. On adding a little muriatic acid, however, the copper became converted into the green modification of the chlorid, and every trace of blue disappeared leaving the liquid with the peculiar gray color. With nitrate of copper and chlorid of cobalt also, no perfect neutralization could be effected, but the same gradual passage of one into the other presented itself. Addition of muriatic acid however produced the same effect as before. These observations, and others that I have made, have an obvious bearing upon the question of the manner of interdistribution of two acids and two bases in a solution together, and promise to furnish us with a new and valuable means of investigating this important problem. The subject will therefore be resumed at a future opportunity.

There does not seem to be much present prospect of devising any substitute for the expensive chlorid of cobalt for nullifying blue and green colors, at least in the indigo test. The color of the *manganese* chlorid is too feeble. *Permanganic acid*, which approaches in color to cobalt solutions, is of course inapplicable. Some experiments with permanganic acid gave, however, interesting results. On throwing a little chameleon mineral into very dilute acetic acid, a rich amethyst-colored solution is immediately formed, with effervescence from escape of oxygen. This solution destroys the green color of chlorid of nickel as perfectly as chlorid of cobalt, the resultant tint moreover being extremely similar; with chlorid of chromium in certain proportions an approximate color was produced, but in whatever proportions the two were mixed, a trace of residual red or blue was always left; with chlorid of copper a fine deep violet-blue color, like that of the ammonia-sulphate, was produced.

I desire here to urge upon the attention of chemists this general subject of the mode of interference of colors with each other when in admixture. It seems to me to present a wide and highly promising field of research, the exploration of which would lead to valuable practical results, and probably furnish us with explanations of many phenomena at present considered obscure. Indeed, results of the latter kind have already been foreshadowed and exemplified by the investigations of Gorgeu upon the colors of manganese compounds (Liebig und Kopp's Jahresb. für 1853, 358; Am. Jour. Science, [2], xvi, 416), which explain perfectly the discrepant observations previously made upon these colors, by the interfering colors of impurities. In connection with such investigations a *scale of colors*, founded upon fixed natural standards, if such a thing could be devised, would of course be of great importance. The modifying influences exerted upon the colors of *precipitates* by the presence of other substances precipitated with them is another branch of the subject fully worthy of special investigation, and would probably lead us to new modes for the qualitative detection of certain substances.

I have made attempts to obtain crystallized double chlorids corresponding to the neutral tinted mixtures of chlorid of cobalt with the green and blue chlorids, but have obtained only negative results. The cobalt chlorid crystallizes out separately or at least only mechanically mixed with a little of the other chlorid. It would be very interesting to determine quantitatively the *proportions* of the several other chlorids which produce the neutral tint with that of cobalt.

when any interfering substance is present, as above recommended. If neutral, chlorid of sodium is added, instead of muriatic acid, to avoid dilution. If carbonate of soda has been used to precipitate iron, lead, baryta, etc., it is better to *concentrate* somewhat before acidulating with chlorohydric acid. Indigo solution (which should also be strong) is then added until a feeble blue tint (best perceived by holding the test tube *inclined from* the operator on a piece of white paper) is communicated. The mixture is then warmed, and concentrated oil of vitriol added *cautiously* (to avoid explosive ebullition) with constant agitation. If but traces of nitric acid be present the bleaching may not take place for some minutes, or until a considerable quantity of oil of vitriol has been added. If the oil of vitriol be free from iron and nitric or nitrous acid (which latter two contaminations may be removed by previous boiling with a little oxalic acid, after the method of Löwe), it is not necessary that it should be otherwise pure. After the bleaching point has once been reached, if a fresh portion of indigo solution be added, it will generally be bleached *immediately*. In this way I detect practically and certainly one part of NO^5 (as saltpetre) in 25,000 parts of water. In 50,000 parts the reaction is no longer distinct, and the liquid must be concentrated after addition of excess of carbonate of soda. The function of the sulphuric acid is not merely, as appeared to me at first, to appropriate the water present, and produce a *quasi-concentration*, for chlorid of calcium cannot be successfully substituted for it. It seems probable that in the presence of a large excess of sulphuric acid, Gay-Lussac's NO^2Cl and Cl^2 are formed, instead of NO^2Cl^2 and Cl. When this mode of manipulation is used, the presence of ammoniacal salts does not seem to exert any unfavorable influence.*

* Before leaving the subject I must present some further observations on which I cannot but *hope* to found a method of testing for nitric acid in the presence of iron. I find that metallic iron (*pulvis ferri*) reduces ferric to ferrous oxyd readily even at the ordinary temperature, whilst nitric acid (free from NO^3) unless very concentrated, does not reoxydize the protosalt. In fact it is already well known that in dilute acid solutions containing nitric and no nitrous acid, iron decomposes water just as in dilute sulphuric acid, and ferrous nitrate is formed. If then means could be contrived to obviate wholly the interference of atmospheric oxygen during the operation of *filtration*, it would be very easy, by acidulating the liquid to be tested with chlorohydric acid, adding a little protosulphate of iron and *pulvis ferri* in the cold, filtering, boiling the filtrate (during which last operation ferric salt would be formed from the ferrous, at the expense of the oxygen of the nitric acid) and then testing for sesquioxyd of iron, to detect nitric acid in the minutest quantities. This would also furnish us with a means of separating qualitatively nitric and nitrous acids.

Art. VII.—*Electrical Phenomena in Houses.*

1. *On the Electrical Phenomena observed in certain houses in New York;* by Elias Loomis, Professor of Mathematics and Natural Philosophy in New York University.

Read before the American Association at the Baltimore meeting, May, 1858.

At the meeting of the American Association for the Advancement of Science held at New Haven in August, 1850, I gave an account of some remarkable electrical phenomena observed in certain houses in New York. That account was received at the time with some surprise; but it soon appeared that similar phenomena had been observed in a much larger number of houses than had been supposed, and every one who was at first skeptical about the facts had an opportunity of convincing himself by personal observation. At present I am not aware that there is any person in the United States who doubts the truth of the statements which I made at New Haven in 1850, or who charges them with exaggeration.

The winter of 1856–7 I spent in Berlin, and I mentioned the leading particulars of these phenomena to some of the professors of the Berlin University. They all expressed very great surprise at my statements, and some of them took no pains to conceal their incredulity. In August, 1857, I attended the meeting of the British Association at Dublin, and made a short communication on the same subject to that Association. The facts were considered very remarkable, and I could not learn that anything similar had ever been observed in any part of Europe. I then decided to improve the first opportunity on my return to New York, to verify my former observations, and to procure the concurrent testimony of a second witness to corroborate my statements. The house in which my principal observations in 1850 had been made was the house of Mr. D. W. Catlin, a merchant of New York, who resides in Fourteenth street. Upon my stating the case to Mr. Catlin, he gave me full liberty to make such additional observations and experiments in his house as I might desire.

The past winter has proved unusually mild, and for many weeks it seemed doubtful whether a favorable opportunity would be presented for witnessing these electrical phenomena, as it is only in extremely cold weather that they are at all remarkable. About the middle of February, 1858, the first opportunity presented itself. On the morning of Feb. 11th the external thermometer stood at 12°; on the morning of the 12th it stood at 16°; on the morning of the 13th it stood at 18°. On the evening of the 12th, the thermometer then standing at 24°, I called at Mr.

Catlin's in company with Prof. Samuel St. John, Professor of Chemistry in the College of Physicians and Surgeons of this city. We found the parlors at a temperature of 70°, and the electricity was quite noticeable, although by no means so abundant as at my visit in 1850. We first measured the *length* of the spark by employing two brass balls supported on glass rods in such a manner that the distance between the balls could be regulated at pleasure. The diameter of one ball was $\frac{3}{8}$ inch, that of the other $\frac{9}{10}$ inch. When Mrs. C. walked briskly across the room and touched one of the balls with her finger, the other ball being in communication with the gas-pipe, the spark would not pass from one ball to the other if the distance much exceeded *one quarter* of an inch, yet this spark was quite intense, and was accompanied by a good snap. When I skipped across the room in the same manner, I gave a bright spark, but it would not pass through a distance quite as great as that furnished by Mrs. C.

We next attempted to light the gas from the chandelier by means of the spark. One of the burners was extinguished, and when its temperature had fallen to about blood-heat, Mrs. C. attempted to light the gas by a spark from her finger. Three or four of the first attempts were unsuccessful; perhaps because the gas was not flowing freely at the time; perhaps because the spark passed on one side of the gas-jet. At length Mrs. C. took a pocket-key in her hand, and skipping briskly across the room, gave a spark from the handle of the key which ignited the gas.

We next poured a small quantity of ether into a shallow metallic cup, and attempted to ignite it by a spark from the finger. The first attempts were unsuccessful; generally because the spark was received on the side of the dish, and did not pass through the ether. After a few trials the ether was fired by a spark from Mrs. C.'s finger.

We next received a succession of sparks upon the knob of a Leyden jar, and I received the charge through my body. The shock was sufficient to convulse my arms somewhat unpleasantly.

We next suspended a pith-ball by a silk thread, and having rubbed a stick of sealing-wax upon the carpet, electrified the pith-ball. After skipping across the room, I presented my finger to the pith-ball and found it violently repelled, showing that the electricity of my body was of the same kind as that of the sealing wax, which conforms to the result which I published in 1850. It should be remarked that before commencing the preceding experiments, I exchanged my boots for a pair of dry slippers with thin soles.

On the evening of March 5th, 1858, Prof. St. John and myself made a second visit to the house of Mr. Catlin. The sky was free from clouds, but the stars shone somewhat dimly. The external thermometer stood at +7°. On the morning of the 5th

the thermometer stood at +8°; and on the morning of the 6th at +12°. We found the temperature of Mr. Catlin's parlor 69°, and the electricity was more abundant than at our previous visit. We first measured the length of the spark by means of the same apparatus we employed in our former experiments. The balls were at a distance of one-third of an inch. I again exchanged my boots for a pair of dry slippers, and after skipping briskly across the room and touching one of the balls with my finger, the spark passed to the other ball. I succeeded in passing a spark when the distance of the balls slightly exceeded one-third of an inch, and the spark from Mrs. C.'s finger passed a little farther than my own; but even this would scarcely pass a distance of four-tenths of an inch.

We next attempted to light the gas from a burner which was quite cool. We allowed the gas to flow for a time in order to be sure that the atmospheric air was all expelled. Prof. St. John then held his finger over the opening, and I took in my hand a brass rod terminated with a small ball. I skipped across the room and applied the ball to the burner, but the gas was *not* ignited. The spark evidently passed a little on one side of the gas-jet. A second trial failed, and evidently for the same reason. The third time I presented the ball to the burner with more caution, the spark passed through the gas, and *the gas was ignited.*

We next repeated the experiment with ether in a metallic cup. Prof. St. John held the cup in his hand, and after shuffling across the room, I presented the brass ball to the surface of the ether, but it was not ignited. A second time the experiment also failed; but the third time, after skipping a little more actively across the carpet, I succeeded in firing the ether.

What are the circumstances most favorable to the success of the preceding experiments?

1. A low temperature of the external air. I have never heard that any phenomena of this kind have been observed except during that period of the year when the houses are warmed by fires; and the phenomena are most remarkable during the coldest weather. The electricity is not abundant unless the external temperature is below 32°; and it is most abundant when the thermometer sinks to the neighborhood of zero. I have never heard of a single fact at variance with this statement.

2. A high temperature of the interior of the house, accompanied by considerable dryness of the air. In a cold room even when the external thermometer is at zero, but little electricity can be obtained by friction upon a carpet. A high temperature is needed, and the higher the temperature the better; and in those houses in which the electricity has been most abundant, a high temperature is preserved almost uninterruptedly during the winter season. In all my observations at Mr. Catlin's house, the

thermometer in the parlors stood at about 70°. From all the facts which I have been able to collect, I infer that a furnace placed in the cellar, and sending its heat through flues to the parlors and other portions of the house, is more favorable to electrical excitement than any other mode of heating, whether by means of a stove or an open grate. Perhaps the only reason for this difference is that when a furnace is used, the entire house is more sure to be kept thoroughly warm and dry. On many of the furnaces in New York, perhaps on most of them, a dish of water is placed to supply moisture to the heated air; but it is also true that in all the modern and well-built houses in New York, so far as I have observed or heard, particularly in those which are warmed by furnaces, the doors and wainscot, together with the furniture, during winter habitually shrink and crack, indicating a very dry atmosphere.

3. A thick and substantial woolen carpet. My own observations and information lead me to the following conclusions: that without a carpet the phenomena I have been describing are wholly unknown; that with an ordinary Ingrain carpet, but feeble electricity is obtained; a second carpet or a drugget spread upon the first improves its electrical qualities. A Brussels carpet is much better than an Ingrain; and a heavy velvet carpet is decidedly the best of all. The carpet unquestionably serves as an insulator to preserve the electricity from being dissipated; and I also regard it as performing a still more important function.

4. A dry slipper, with a sole not very thick, appears to be favorable to the success of these experiments. A boot or shoe with a moist sole succeeds but poorly. Ladies are generally more successful in these experiments than gentlemen, chiefly, I think, from the fact that the soles of their shoes are ordinarily thin and dry. In my experiments at Mr. Catlin's house, I gave but a very feeble spark when dressed in boots; but after I had put on a pair of dry slippers, I gave a spark nearly equal to that given by Mrs. Catlin. A shoe with a thin sole is preferable to a boot with a thick sole, partly because the latter is less likely to be thoroughly dry, and therefore not so well adapted to exciting electricity, and also because, even if it were perfectly dry, its great thickness would interfere with the communication of the electricity to the body as fast as it was excited.

What is the source of the electricity observed in the preceding experiments?

In my paper published in 1850, I gave it as my opinion that the electricity was excited by the friction of a leather shoe upon a woolen carpet. I proved by direct experiment that by such friction, electricity was actually excited; and I still believe that this is the principal, if not the only, source of the electricity.

Some have thought that the electricity was due, at least in part, to the dress of the experimenter. I have satisfied myself that electricity may be excited in shuffling across a carpet by any person, no matter what his dress may be, provided only that he have shoes with a dry leather sole. Children of all ages, boys and girls, as well as persons of mature years, excite electricity in the same way. I have never heard of an individual who had tried the experiment in a house similar to that of Mr. Catlin's, without exciting considerable electricity. No particular material or quality of dress is essential to the success of the experiment.

It is a very common impression, and one which is countenanced by my own observations, that a silk dress is favorable to the electrical excitement. A silk dress saves the electricity which is accumulated upon the person from being dissipated as fast as it is excited; but I do not think the silk dress performs any important active part in the electrical excitement. I believe it is true that ladies generally succeed better in these experiments than gentlemen, and ladies generally succeed best when they wear a silk dress; but from the statement of Prof. St. John which accompanies this paper, it appears that small boys in their ordinary woolen dress, may be equally electrical; and I am inclined to think that the uniform success of ladies in these experiments is due to the fact that they are more habitually confined to the house; and their dress, particularly the shoe, is more thoroughly dry.

Some have imagined that a silk wrapper worn next to the skin was important to the success of these experiments; but this is by no means essential, for one of the most electrical cases of which we have any knowledge was that of a boy described in Prof. St. John's communication, whose dress contained not a particle of silk, and who wore cotton next to his skin.

2. *Notice of some Electrical Phenomena witnessed in houses in the cities of New York and Cleveland, Ohio;* by SAMUEL ST. JOHN, Professor of Chemistry in the College of Physicians and Surgeons, New York City.

Read before the American Association, at the Baltimore meeting, May, 1858.

BY invitation of Prof. Loomis of the New York University, I accompanied him on the evening of the 12th of February, 1858, to witness some experiments on electricity, exhibited in a house in Fourteenth street in the city of New York. The rooms in which the experiments were performed had upon the floors thick velvet carpets and the usual furniture of elegant houses; they are warmed by furnaces, and are kept at a nearly uniform

temperature of 70° F. The experiments were performed by the gentleman and lady of the house and Prof. Loomis who had put on dry slippers. After walking rapidly through the parlors with a shuffling motion, very bright electrical sparks were exhibited when the hand was presented to the chandeliers or other good conductors communicating with the ground. Gas was ignited at one of the burners by a spark from a key in the hand of the lady, and sulphuric ether inflamed by the spark passing from her finger to the liquid which I held in a metallic cup in electrical connection with the earth. The spark was made to pass between two small insulated brass balls, with a view to measure its length. The greatest length attained was one-fourth of an inch. The spark exhibited a beautiful appearance in a darkened room, when the fingers were brought near to the wall-paper, dispersing itself through the space of a foot or more over the gilded ornaments of the paper. On the evening of the 5th of March, the coldest day of the season, the experiments were repeated in the same rooms, when a sensible increase of electrical intensity was discerned. The gas and ether were inflamed by Prof. Loomis holding a brass ball in his hand; and the length of the spark attained was a little more than one-third of an inch.

These phenomena were similar to such as I often witnessed during the winters of 1854–5 at the Cleveland Female Seminary, located in the southeast quarter of the city of Cleveland, Ohio. The building is three stories high, of brick, with a sandstone basement, and is warmed by three furnaces supplied with the ordinary bituminous coal of southeastern Ohio, the fires declining but not becoming extinct during the night. The temperature of the rooms varied considerably, sometimes rising above 80° but rarely falling below 60°, even during the night. The rooms in which the electrical manifestations were conspicuous, were the parlors on the first floor above the basement. The floors of these rooms were covered with substantial Brussels carpets. The seasons when they attracted especial attention were periods of severely cold weather—the thermometer on one occasion indicating 23° below zero; the electrical excitement diminished in mild weather, and ceased entirely when it rained. The carpets on the halls and other rooms were thinner fabrics than Brussels carpeting, or composeed partly of cotton or linen, and upon these the electrical phenomena were barely discernible. In the parlors, electricity was manifested during dry cold weather at all hours of the day, but much more strikingly in the evening after the young ladies had spent an hour in recreation and dancing. On such occasions the intensity of the spark was such as readily inflamed ether and pulverized resin, and measured repeatedly one-half inch, passing between insulated balls to the furnace register, which was in good electrical communication

with the earth. All persons remaining in the rooms were enabled to communicate sparks to conductors, but the longest sparks were given by two boys of the ages of nine and eleven years, after running and sliding upon the carpets; this we attributed to the friction evolved by their unconstrained freedom of motion. These boys wore dry slippers, were clad in woolen, one of them wearing flannel next to his person and the other cotton, the latter, who was of more vigorous constitution and active habits, giving the more vivid spark. A difference of electrical accumulation was also discernible among the young ladies, which we were inclined to ascribe to diversities in their dress, silk, woolen, cotton—the silk and woolen appearing more favorable to success. In one instance the different degrees of moisture upon the skin seemed to affect the amount of electricity communicated. These phenomena attracted the attention of all the inmates and visitors of the seminary; many persons expressing surprise and some consternation on receiving a shock as they entered the room and took the hand presented to welcome them preceded by a vivid spark. The passage of the spark over glass by bits of tinfoil disposed in letters and in the 'spiral tube,' together with the usual experiments on electric light, were repeatedly exhibited as a source of amusement.

ART. VIII.—*Mineralogical Notices;* by Prof. GEORGE J. BRUSH, of the Yale Scientific School.

1. *Gieseckite?*

DURING the summer of 1857, while on a visit to the celebrated mineral locality at Diana, Lewis county, N. Y., my attention was called to a green mineral crystallizing in large hexagonal prisms. In external appearance it resembled apatite, but on analysis it proved to be a silicate. Dr. Geo. N. Hubbard of Natural Bridge has kindly supplied me with a number of these crystals, from which I am able to give the following characters.

The mineral is found in a highly crystalline limestone and is associated with a brown augite and with magnetic pyrites; those crystals which are exposed are coated with a thin layer of black oxyd of manganese, derived from the water of a stream which overflows the locality several months every year. It occurs in stout prisms from a quarter of an inch to two and a half inches in length. The crystals are six-sided, and are terminated by a plane at right angles to the prism; generally, however, the basal edges are replaced by the planes of a pyramid. The corresponding planes in different crystals do not give constant angles, as

will be seen from the following table containing the measurements of several crystals numbered 1 to 6.

No.	Inclination of base on				Prismatic face (*I*) on				*I* on base, over			
	1	1*b*	2	3	1	1*b*	2	3	1	1*b*	2	3
1	135° 30′	137°	135° 10′	135° 20′		133°	135°	134° 40′	90°	90° 40′		
2	133° 20′		135°		134°		134° 30′		87°		89° 20′	
3	139°	138°	135° 20′	135° 20′	130°		134° 40′		89°		90°	90°
4	135° 20′		135° 40′		134° 40′		134° 20′		90°		90°	
5	138°	135° 40′			131°				89°	91°		
6	137°		135° 40′				135°				90° 40′	

The planes of the pyramid at one end of the prism are numbered 1, 2, 3, 1*b*, 2*b*, 3*b* in order around; 1*b* being opposite to 1. Crystal No. 3 was terminated at both ends, and while the inclination of the prismatic face *I* on 1 at one end was 130°, (as stated above,) the same *I* on 1 at the other end was 134° 30′. The "prismatic face *I*" referred to in the table is in each case that plane of the prism which is in the same vertical zone with the pyramidal plane mentioned. In Nos. 1, 2, 3, 4 and 6, the angle between the faces of the prism was 120°.

Many of the crystals have a perfect cleavage parallel to the faces of a hexagonal prism, the cleavage being equal and like in lustre in the three directions. In other specimens the cleavage is scarcely perceptible and some show no traces, but break with a waxy fracture. The thin layers from cleavable crystals are not themselves cleavable like those of true crystals, but have generally the compact waxy fracture of the uncleavable crystals. The color varies from light pea-green to leek-green, and the lustre from vitreous to greasy. Thin pieces of the mineral are translucent. Hardness =3—3·5. Specific gravity 2·736—2·75. Before the blowpipe in forceps becomes opaque and fuses to a white enamel; in the glass tube gives alkaline water; with salt of phosphorus gives reactions for silica and iron. Decomposed by acids without gelatinizing. The powdered mineral heated over a blast lamp in a platinum crucible agglomerates to a semi-fused mass which can no longer be decomposed by acids.

As the crystals vary so much in their crystallographic and physical characters I expected to find a like variation in their chemical composition, and in order to test this point three specimens differing considerably in appearance were selected, and a complete analysis was made of each.

Qualitative examination showed the presence of silica, alumina, iron, lime, magnesia, potash, soda, and water, together with a small amount of carbonate of lime, due to mechanical mixture with calcite, the last traces of which it was found difficult to separate from the mineral as selected for analysis.

In the quantitative determinations, the mineral was decomposed by carbonate of soda; the alkalies were determined by Smith's method. In one case the water was determined directly

by heating in a glass tube in a stream of dry air and collecting the moisture in a chlorid of calcium tube, and in the two other analyses the loss by ignition was considered as water after subtracting from it the small amount of carbonic acid which the mineral was found to contain. The following are the results: The material for analyses Nos. 1, 2 and 3 was taken from three crystals differing considerably in external characters: No. 1, uncleavable; No. 2, distinctly cleavable; No. 3, mixed cleavable and uncleavable. Nos. 4 and 5 are two determinations made on No. 3 to ascertain the state of oxydation of the iron.

Sp. gr.,	2·75	2·749	2·736		
	1.	2.	3.	4.	5.
Silica,	45·55	45·75	45·70		
Alumina,	31·62	31·25	31·65		
Sesquioxyd of iron,	——	——	——	27	27
Protoxyd of iron,	0·88	1·05	1·10	72	81
Lime,	2·42	1·96	2·21		
Magnesia,	3·38	3·59	3·46		
Soda,	1·06	0·67	0·90		
Potash,	8·11	8·47	8·06		
Water,	7·32	6·58	7·01		
Carbonate of lime,	0·42	0·56	——		

This uniformity of composition was unexpected, and is quite remarkable. The description given clearly shows that the crystals are pseudomorphs. This appears (1.) from the wide variation in angle; for such variations, while hardly known in real crystals that are apparently so perfect in their faces, do exist in crystals that have undergone pseudomorphic changes. It is apparent (2.) in the diversity as to cleavage—cleavage being seemingly perfect in some crystals and wholly absent in others, and the waxy and cleavage structure being at times mixed in the same specimen. It may be inferred also (3.) from the identity of composition under these diversities; for in real crystals so wide differences would be in some way represented in the constitution. But what the original mineral was which has been here altered is a question more difficult to answer. One fact is clear, from the cleavage observed as well as the form, that the crystallization is *hexagonal* and not trimetric.

In physical as well as chemical characters this substance approaches gieseckite, liebenerite and pinite, all of which have been considered as pseudomorphous minerals. In the recent analyses of gieseckite by v. Hauer he obtained:—

	$\dot{S}i$	$\dot{A}l$	$\dot{F}e$	$\dot{M}n$	$\dot{M}g$	$\dot{K}$	$\dot{H}$
1.	46·40	26·60	6·30	*tr.*	8·35	4·84	6·76=99·25
2.	45·36	27·77	——	——	7·39	——	6·87

The iron in No. 1 was given as protoxyd, but no direct determination was made to ascertain the state of oxydation. If it be considered as sesquioxyd, and we compare the oxygen ratio with that of the Diana mineral, we have:

	$\dot{R}$	$\ddot{R}$	$\ddot{S}i$	$\dot{H}$	
Gieseckite,	4·16	: 14·53 :	24·10	: 6·01	= 1 : 3·50 : 5·88 : 1·44
Diana mineral,	4·00	: 14·80 :	23·88	: 6·19	= 1 : 3·70 : 5·97 : 1·55

These ratios are so nearly alike, that the Diana mineral is probably gieseckite in which a portion of the magnesia is replaced by an equivalent amount of lime and potash. The oxygen ratio may also be expressed by $\frac{1}{3}\dot{R} : 2\frac{1}{3}\ddot{R} : 4\bar{S}i : 1\ddot{H}$, which gives the formula $(\frac{1}{3}\dot{R}^3 + \frac{7}{3}\ddot{R})^3\bar{S}i^4 + 3\ddot{H}$, or more simply $(\dot{R}^3, \ddot{A}l, \ddot{H}^3)\bar{S}i$.

The researches of von Hauer and Kenngott show that gieseckite and liebenerite are closely related to each other. They are both hexagonal and both have many of the physical properties of the Diana mineral. They all have nearly the same composition as the pinite from Auvergne and from Saxony as given by Rammelsberg and Marignac.

Pinite is stated to be hexagonal by the earlier mineralogical writers, but Haidinger* has referred it to the trimetric system, and classes it as an altered iolite. Phillips, however, gives a figure of pinite from Puy de Dome with measurements which seem to prove it to be hexagonal. Marignac also favors the idea that it is hexagonal. But, whatever the fact about pinite, the form of liebenerite and gieseckite, like that of the Diana mineral, is unmistakably hexagonal.

The close relation of these minerals in chemical composition is seen from the following analyses.

	$\bar{S}i$	$\ddot{A}l$	$\ddot{F}e$	$\dot{F}e$	$\dot{M}n$	$\dot{C}a$	$\dot{M}g$	$\dot{K}$	$\dot{N}a$	$\dot{H}$	
1. Liebenerite,	45·13	36·50	2·63	—	—	0·81	0·75	8·07	0·42	4·70	Oellacher.
2. "	44·47	36·56	1·77	—	—	—	1·33	9·89	0·92	5·06	Marignac.
3. "	44·45	38·75	2·26	—	—	1·58	*tr.*	6·45	2·79	4·75	v. Hauer.
4. Gieseckite, Greenland,	46·40	26·60	—	6·30	*tr.*	—	8·35	4·84	—	6·76	"
4a. " "	46·40	26·60	7·00	—	*tr.*	—	8·35	4·84	—	6·76	"
5. " Diana,	45·66	31·53	0·27	0·77	—	2·20	3·48	8·21	0·88	6·97	Brush.
6. Pinite, Auvergne,	47·50	31·80	—	3·92	—	—	1·78	9·05	0·92	5·03	Marignac.
7. " St. Pardoux,	48·92	32·29	3·49	—	0·11	0·51	1·30	9·14	—	4·27	Rammelsb.
8. " Mont Brévent,	44·70	31·64	—	6·57	—	—	2·86	7·89	0·95	5·39	Marignac.
9. " Aue,	46·83	27·65	—	7·84	—	0·49	1·02	6·52	0·40	7·80	Rammelsb.
10. " Penig,	47·00	28·36	—	7·08	—	0·79	2·48	10·74	1·07	3·83	"
11. " Penig,	48·00	28·00	—	9·66	—	0·75	—	11·35	—	3·00	Scott.
12. " Saxony,	46·10	32·46	—	4·27	—	—	2·26	9·00	0·46	5·45	Marignac.

1 and 2 as quoted by Kenngott in Sitzungsberichte Wien Akad., ix, 597.
3. v. Hauer, Jahrbuch k. k. geologische Reichsanstalt, 1853, 147.
4. " " " " " 1854, 76.
4*a*. " same analysis, with iron calculated as $\ddot{F}e$.
5. mean of three analyses.
6, 8 and 12, Marignac, Bibliothèque Universelle de Genève, 1847, 159.
7. Rammelsberg Mineralogie, Suppl. iv, 178.
9 and 10. " " Suppl. iii, 94.
11. " " ii, 60.

This similarity in chemical composition would seem to indicate a common origin for these pseudomorphous minerals. Tamnau† endeavors to show that the Greenland gieseckite is altered nepheline, but he does not support his opinion by analyses. Blum‡ and Bischof§ consider both gieseckite and liebenerite to be altered nepheline, although the relation to nepheline is not clearly shown; while Kenngott‖ suggests that they may have

* Pogg. Ann. lxvii, 454. † Pogg. Ann. xliii, 149. ‡ Nachtrag, ii, 131.
§ Lehrbuch der chemischen und physicalischen Geologie, ii, 2259.
‖ Sitzungsberichte Wien Akad., ix, 604.

been derived from some unknown mineral. We are not in possession of facts which warrant a positive decision. Some of the Diana crystals certainly have the lustre, color, and general aspect of elæolite.

It is noteworthy that in northern New York and in Canada there is a class of rocks represented by parophite and dysyntribite which are hydrous silicates of alumina and potash. Moreover, the potash agalmatolites approach these in chemical composition,* as will be seen from the following analyses. The dysyntribite in fact occurs at Diana, and may have had a similar origin with the crystals here described. But I would not assert that the same potash-silicate may not tend to form from the alteration of different silicates.

		Si	Al	Fe	Fe	Mn	Ca	Mg	K	Na	H	
1.		48·50	27·50		5·67	—	1·30	2·24	5·30	1·91	7·00	T. S. Hunt.
2. Schistose parophite,		48·42	27·60		4·50	—	2·80	1·80	5·02	2·78	6·88	"
3.		48·10	28·70		4·80	—	2·10	1·41	4·49	1·53	8·40	"
4. Dysyntribite,		46·65	31·23	3·69	—	*tr.*	*tr.*	0·50	11·68	*tr.*	5·03	Smith & Brush.
5.	"	44·78	35·39	2·76	—	0·30	0·59	0·48	6·87	3·60	5·05	"
6.	"	44·94	25·05	3·33	—	*tr.*	8·44	6·86	5·80	*tr.*	6·11	"
7.	"	44·42	20·81	4·15	—	*tr.*	12·62	8·52	3·82	*tr.*	5·58	"
8. Agalmatolite, China,		49·82	29·60	—	1·50	—	6·00	—	6·80	—	5·50	Thomson.
9.	" Schemnitz,	49·50	27·45	—	1·03	*tr.*	5·56	0·72	10·20		5·10	Kurafiat.

1, 2, 3, Hunt, abstract from Geol. Rep. Canada for 1852, 95, in this Journal, [2], xvii, 127. 4, 5, 6, 7, analyses of different specimens of dysyntribite showing it to be a rock and not a simple mineral, this Journal, [2], xvi, 50. Its relations to pinite are shown in this paper. 8, Thomson's Mineralogy, i, 343. 9, Pogg. Ann., lxxviii, 575.

2. *Compact Pyrophyllite.*

In a recent examination which I have made of some varieties of Chinese figure-stone (agalmatolite), one specimen analyzed proved to be identical in chemical composition with pyrophyllite, and on reference to Dana's Mineralogy, p. 253, was found an analysis of Chinese agalmatolite by Walmstedt, which gave a similar result. This led me to consult the Oefversigt af Kongl. Vetenskaps-Akademiens Förhandlingar for 1848, p. 111, in which three analyses by Walmstedt are given. His results are communicated by Svanberg in a note to Sjoegrens analyses of Swedish pyrophyllite.

It is somewhat remarkable that Svanberg's note seems to have been entirely overlooked by mineralogists, for in it he calls attention to the fact that this agalmatolite is identical with the Swedish pyrophyllite, as also with that from Spaa analyzed by Rammelsberg.

* Prof. T. Sterry Hunt, of Montreal, has called my attention to the near relation between the composition of the Diana gieseckite and his analyses of the minerals algerite (this Journal, [2], viii, 105) and wilsonite (ib., xix, 428),

	Si	Al	Fe	Mg	K	Na	Ca	H
Algerite,	52·28	26·08	1·93	1·20	10·69	—	—	7·92
Wilsonite,	47·70	31·22	—	4·14	9·38	0·95	0·39	5·35

The facts seem to sustain the suggestion above, that the same potash-silicate may result from the alteration of different mineral species. This is an important subject for further investigation.

The specimens that I have examined were brought from China by Dr. M. C. White of New Haven. Dr. White informs me that the Chinese obtain this "figure-stone" from the mountains, about twenty English miles from Fuhchau.

The mineral has a white to greenish-white color and is translucent; it is perfectly compact, sometimes veined like marble, the color of the veins being dark red and due to the presence of sesquioxyd of iron. B.B. infusible, or fusible only on the thinnest edges; moistened with nitrate of cobalt gives the reaction for alumina; not decomposed by acids. Hardness 3. Specific gravity 2·81. Analysis showed it to be a hydrous silicate of alumina with traces of iron, lime, magnesia, and alkalies. Of the following Nos. 1, 2 and 3 are the original analyses by Walmstedt, and No. 4 is my analysis.

	Si	Al	Fe	Ca	Mg	Sn	K, Na	H
1.	65·96	28·58	0·09	0·18	0·15	—	—	5·16
2.	66·38	27·95	0·06	0·18	0·06	—	—	5·20
3.	65·65	28·79	0·28	0·23	*tr.*	*tr.*	—	5·11
4.	65·95	28·97		0·22	—	—	0·25	5·48

Their close correspondence with pyrophyllite may be seen by comparing them with the following analyses of that species:

	Si	Al	Fe	Ca	Mg	Mn	H	
Pyrophyllite from Spaa,	66·14	25·87	—	0·39	1·49	—	5.59	Rammelsberg.*
Westana,	67·77	25·17	0·82	0·66	0·26	0·50	5·82	Sjoegren.†
Sp. gr.=2·78,	65·61	26·09	0·70	0·69	0·09	0·09	7·08	
Chesterfield District, N. Car.,	64·82	28·48	0·96	0·55	0·33	—	5·25	Genth.‡
	66·01	28·52	0·87	0·23	0·18	—	5·22	

This so-called agalmatolite may therefore be considered as a compact pyrophyllite. The formula $\dot{Al}^2\ddot{Si}^9+2\dot{H}=\ddot{Si}$ 65·66, $\dot{Al}$ 29·22, $\dot{H}$ 5·12, represents very well the composition of both varieties.

It is true that the compact mineral does not swell up and spread into fan-like shapes as is the case with the foliated variety, but this is simply due to a difference in structure; the same circumstance explains the difference in fusibility. The compact pyrophyllite seems to bear the same relation to the foliated variety, as steatite bears to foliated talc.

The formulæ of talc and pyrophyllite are as follows:

Talc, $(\dot{Mg}^6)^2\ddot{Si}^9+2\dot{H}$,
Pyrophyllite, $\dot{Al}^2\ddot{Si}^9+2\dot{H}$.

It is hence obvious that the two are analogous in chemical composition.

3. *Unionite.*

In this Journal, [2], xv, 211, Prof. J. Lawrence Smith and myself published analyses of a mineral which we supposed to

* Pogg. Ann., lxviii, 513.
† Oefv. K. V. Ak. Förh., 1848, 110.
‡ This Journal, [2], xviii, 410.

be the unionite of Silliman. We had no reason to doubt the authenticity of our specimens, as they were collected at the unionite locality by Mr. L. White Williams, and were received by us from Prof. B. Silliman, Jr. A careful examination, however, of the original specimen in Prof. Silliman, Jr.'s cabinet, showed such a difference in the physical characters that I have been induced to make an analysis of the original specimen from material kindly furnished me by Prof. Silliman, Jr.

Its physical characters correspond perfectly with those given by Silliman. B.B. fuses easily, with intumescence, and glows with a white light. In the tube yields water. Sp. gr.=3·299. After ignition it gelatinizes with hydrochloric acid. Analysis of 1·036 grams fused with carbonate of soda gave:—

		Oxygen.	
Silica,	40·61	21·10	3
Alumina,	33·44	15·63	2
Sesquioxyd of iron,	0·49	15	
Lime,	24·13	6·86	1
Magnesia,	*tr.*		
Ignition,	2·22		

The oxygen ratio is that of epidote, and the analysis agrees with Rammelsberg's analyses* of zoisite. Its physical characters are also identical with zoisite, and it forms one of the purest varieties of lime-epidote.

4. *Feldspars from the Danburite locality.*

Prof. J. Lawrence Smith and myself have shown† that danburite is associated with both orthoclase and oligoclase. This locality has been re-opened during the past year, and the feldspar now obtained there is chiefly orthoclase. It forms a vein in dolomite from one and a half to two feet in width, and occurs in broad cleavable masses as well as in the more compact granular form before observed and analyzed by Smith and myself.

The cleavable variety has recently been analyzed by Mr. Geo. F. Barker of the Yale Scientific School, with the following result:

	$\dot{S}i$	$\dot{A}l$	$\dot{C}a$	$\dot{K}$	$\dot{N}a$	Ign.
Sp. gr. 2·58.	64·25	18·80	1·20	12·44	2·40	0·30=99·39

The specimens of danburite which were taken from the locality some years since, and from a part of the vein only about two hundred feet distant from the present opening, were not unfrequently found imbedded in oligoclase.‡ This feldspar may be easily distinguished by the fine parallel striæ in one direction (indicative of a triclinic form) observable on its cleavage surface; these striæ are entirely wanting in the other feldspar. It appears therefore that in the same vein, danburite is sometimes imbedded in a potash feldspar and in other cases in a soda-lime feldspar.

Yale Analytical Laboratory, March, 1858.

* Pogg. Ann., c, 133.

† This Journal, [2], xvi, 44.

‡ For analyses, see loc. cit.

ART. IX.—*Fish-rod Balance and Spheroidal Evaporation;* by J. L. RIDDELL, Prof. Chem. in the Med. Dep. of the University of Louisiana.

MESSRS. EDITORS:

I HAVE read an article in your number for January, 1858, p. 39, by Prof. Alfred McMayer, on "the estimation of the weights of very small portions of matter." That he independently invented the instrument therein described, I have no reason to entertain doubt. In 1840, while residing at the U. S. Branch mint of this city, I invented, constructed and used a similar contrivance. I called it the fish-rod balance. I formed a minute tapering hollow tube of glass, mounted it adjustable in a glazed case to avoid drafts of wind, suspended from the small and free end an extremely light pan by a thread of glass, terminating in an indicator point, the point traversing over a micrometer scale, a view of which was commanded by a microscope. Values were written upon the scale from observation, at intervals, and carried out by interpolations. I operated more or less with this instrument for six years, during which time it was inspected by hundreds of persons now living. Prof. McMayer under-estimates its delicacy and over-estimates its reliability.

The purpose to which I mostly applied it, was to determine the amount of non-volatile matter in liquids. Thus: a pipette, marked so as to contain a measure, the equivalent of one gram of water, containing the liquid to be evaporated, was held inclined over a clean silver or platinum capsule, heated by a spirit lamp. The liquid, dropped gradually in, assumed the spheroidal form, and was evaporated, but not quite to dryness, lest the residue should be dissipated by explosion. At the proper moment it was skillfully tossed into a clean porcelain capsule, and presented the earthy and saline residue in the form of a minute sphere, generally too minute to be weighed in an assay balance. The fish-rod balance was then resorted to.

But I found the fish-rod balance to vary materially in its indications of weight, from the effects of varying temperature, from molecular changes in the glass becoming manifest in time, and probably from other causes which I did not investigate. Hence I came to think little of it as an accurate means of determining minute weights, and much of it as a probable means of investigating the obscure laws of molecular changes, a vein of inquiry which as yet I have failed to pursue.

New Orleans, April 17, 1858.

ART. X.—*Contributions to the Palæontological Synchronism of the Coal Measures of Ohio and Illinois;* by R. P. STEVENS, M.D.

Is there a stratigraphical synchronism in the two great American coal fields—the Appalachian, and that of the basin drained by the Mississippi river?

I propose to make a contribution of such facts and observations as have fallen under my notice, to assist in the solution of this interesting problem in American geology.

To bring the subject more immediately under the eye, two sections are given. One is of the coal strata of Ohio, as made out by examinations along the line of the Ashtabula and New Lisbon railroad by Dr. J. S. Newberry, and along the Cleveland-and-Pittsburgh and Cleveland-and-Zanesville railroad by myself. The section is carried up to the blue, drab and purple shales and red sandstone which lie between the lower and upper coal-bearing strata of the Appalachian system. The other is taken from the shafts, borings and bluffs at Lasalle, Ill. This portion of the Illinois coal field is selected as offering the best developed system of stratification which is to be found on its northern aspect.

The bare inspection of the two sections will at once satisfy most minds that the solution of the problem cannot be looked for from stratigraphical geology. Indeed, to my own mind, the more numerous the sections, from widely separated localities, the more doubtful the synchronism.

Section.

Ohio.	Feet thick.	Illinois.	Feet thick.
Non-productive shales.		Grey and drab shales,	28
Red sandstone.		Argillaceous limestone (upper fossiliferous),	5
Shales.		Coal,	1
Coal,	1	Clay,	5
Clay,	2	Crinoidal red shale,	20
Shale,	100	Limestone, fossiliferous	15
Upper encrinal limestone,	10	Grey shale, "	5
Sandstone, fossiliferous.		Blue limestone,	5
Shale.		Black shale,	17
Blackband ore.		Blue shale,	10
Coal,	3	Limestone,	3
Clay, Trigonocarpon,	5	Blue shale, fossiliferous,	18
Sandstone (Mahoning?)	50	Grey limestone, "	2
Shale,	5	Blue shale, "	9
Coal, "Big Vein,"	6	Limestone, "	2
Clay,	5	Blue and black shales,	16
Sandstone, non-fossiliferous,	20	Marble limestone, fossiliferous,	4
Coal,	5		

Ohio.	Feet thick.	Illinois.	Feet thick.
Sandstone,	30	Brown and red shales,	18
Shale and nodular iron ore (vegetable fossils),	30	Sandstone,	18
Coal (cannel),	30	Siliceous shales,	36
Shale,	20	Coal,	4½
Limestone, fossiliferous,	3	Clay,	6
Shale, blackband,		Sandstone,	20
Ore, thin coal and limestone,	20	Bituminous shale,	27
Shale,	15	Coal,	6
Sandstone, vegetable fossils,	40	Clay,	5
Blue shale, vegetable fossils,	30	Limestone,	11
Coal,	3	Greyish sandy shale, often sandstone,	66
Shale,	50	Coal,	4
Conglomerate (marine fossils in Pa.),	100	Clay,	2
		Shale,	5
		Basal sandstone,	40
Total,	600	Total,	400

I begin my observations with the basal sandstone known as the coal conglomerate, formation No. XII of Prof. Rogers. This rock in McKean Co., Pa., and Alleghany and Cattaraugus Cos., N. Y., contains, besides others, the following species of marine fossils, viz., Orthoceras 3 species, Murchisonia 2 species, Pleurotomaria 1 species, Myalina 1 do., Avicula 1 do., Lyonsia 3 do., and Orthis 1 do.

In Ohio, according to Dr. Newberry, instead of marine fauna it abounds in Calamites, Lepidodendra, and Trigonocarpa. In Indiana, Calamites (Lyell). Illinois, on the Wabash, Illinois and Big Muddy rivers, Calamites and Lepidodendra are abundant. All specimens seen are fragmentary and water-worn.

The arenaceous character of the matrix, as well as the water-worn character of the specimens, forbid their close examination and identification of species; but their general characteristics, gathered as they are from so wide localities, forbids their separation from each other.

So far as the floral testimony extends, the basal sandstones of the northwest portion of the Appalachian and northern of the Illinois are identical.

The roof shale of the first bed of coal, in the ascending series, both in Ohio and Illinois, is very rich in its flora. Nothing can exceed the beauty, richness and variety of the fretted roof of this vein, as seen in the mines at Cuyahoga Falls and Chippewa, Ohio, or at Morris, Ill.

To Dr. Newberry we are indebted for the development and description of the new and collating of the old genera and spe-

cies of this shale. From the mines of Mahoning and Summit Co., Ohio, even from limited examinations, he has enumerated 41 genera with 150 species. Of these, the following are characteristic of this shale. The beautiful *Whittleseyea elegans*, *Sphenopteris Lesquereuxii*, *S. Kirtlandii*, *S. simplex*, *S. parviflora*, *S. uncinata*, *Alethopteris grandiflora*, *Neuropteris lancifera*. The *Alethopteris Lonchitidis* and *Pecopteris plumosa* he considers identical with *European* species.

The equivalent shale in Indiana and Illinois, over seam of coal No. 1, on the Wabash and at Morris, Ill., is also exceedingly rich in its flora.

As in Ohio and also in Illinois, the lower beds of the series are the most exuberantly stored with the relicts of the Carboniferous flora. This grand generalization is more significant than the identification of individual species. For it has been shown that in Ohio each mine of this lower vein of coal has species peculiar to itself: the *Whittleseya elegans* being found at Chippewa and not at Mahoning, while the *Antholites priscus* is found at the latter and not the former. If this be so over a limited geographical area, much more may we look for it from strata widely separated, as Ohio and Illinois. There is, however, an identification of two species of Lepidodendra, *undet.*: the one having long nearly equally acuminate areolæ, at the upper and lower angles; the length being one and a half inches, the breadth being only seven-tenths of an inch: the other species much smaller, of diamond-shaped areolæ, the length being two-tenths of an inch. These are found at Chippewa in Ohio, Pine Creek, Ind., and Morris, Ill.

According to T. A. Conrad, Esq., the iron-stone layers of Coalbrook, England, and of Tioga Co., Pa., have *Productus scabriculus* as a characteristic fossil. The same fossil is found in similar positions, in McKean Co., Pa., Mahoning Co., Ohio, and in equivalent strata, though the iron is scarcely recognized on the Upper Wabash, Ind., and Illinois river, Ill. In the latter state, there is this difference in the distribution of the fossil. It is found in the mountain limestone and ranges upwards through the coal measures, it being found at Paris, Ill., in this rock (N. and P.), in the middle of the series at Danville, Ill., 40 miles north, and again in the upper shales and limestones at LaSalle, 150 northwest.

The thick-bedded sandstone, sometimes becoming very coarse, and even a conglomerate and sandy shales, intervening between coal No. 1 and No. 2 of both sections, is highly floraliferous in the Mississippi and Appalachian systems. I am not aware of the description or identification of any specimens. The fragmentary and crushed conditions in which they are

generally found would forbid it. Sigillariæ and Stigmariæ are common.*

In the limestone No. 1 of the Ohio section, over the second bed of coal, in the state of Ohio, the *Chonetes mesoloba* and *Productus Wabashensis* are first seen. The following are the localities. Mahoning Co. (Newberry), Tuscarawas Co., Coshocton Co., Columbiana and Jefferson Co., O. They range through some two or three hundred feet of the middle coal measures. At the mouth of Big Yellow Creek they are seen in the upper limestone above all the coal strata. These fossils are found in a limestone between the third and fourth seams of coal at Danville, Ill., and range through the entire series of the Vermillion Co. coal. At LaSalle they are seen in the marble limestone, again at Peru, and range upwards through the series. At Centralia the *C. mesoloba* is seen in the upper shales of the coal measures. In Indiana (New Harmony, N. and P.) they occur in the middle of the series.

The limestones and calcareous shales and clays of both States are highly prolific in marine exuviæ. Dr. Newberry says he found in the limestone over the third bed of coal of Mahoning Co. the following genera, viz., Spirifer, Terebratula, Pleurotomaria, Goniatites, Bellerophon, Loxonema, Productus, Macrocheilus, and adds, "nearly all the genera of Carboniferous fossils." On Yellow Creek, O., the number of genera increases in any given strata as we progress upwards to the limestone which lie between the upper and lower coal series of the Appalachian system; while in the western part of Ohio the genera are about equally numerous throughout the whole series. This may be explained by the well known fact of the greater number and thickness of the calcareous strata of the western part of these coal-fields.

In the Carboniferous strata of both States, the following species have been identified, viz., *Spirifer Kentuckensis*, *S. Forbeseyi*, *S. cameratus*, *S. lineatus*, *Terebratula subtilita*, *T. elongata*, *Terebratulina pentatoma*, *Rhynconella*, spec. undet., *Nucula Hameri*, *Cardiomorpha*, spec. undet., *Cyathophyllum Fungites*, *Cyathaxonia*, spec. undet., *Macrocheilus acutus*, *M. inhabilis*, *Bellero-*

* On the north and northwestern edge of the Appalachian coal-fields this sandstone is often a conglomerate and is liable to be mistaken for formation No. XII, or the true basal coal conglomerate. Thus mistaking it, some geologists have fallen into an error, as I think, in placing a bed of coal beneath the *true* Carboniferous conglomerate. Sections in lately published reports of the McKean Co., Pa., beds of coals give a coal bed thus placed. The distinction which I draw, viz., of the lower conglomerate containing marine animal fossils, while the upper never does, is sufficient at all times to distinguish the two. Moreover, the upper conglomerate usually exhibits fragments of carbon comminuted and rounded, while in the lower all traces of carbon are wanting. And again, the lower conglomerate, in the lower portions, contain fragments of Devonian rocks, or in Illinois, even of Silurian, while the upper is composed of purely siliceous and Carboniferous materials.

phon Urii, B. percarinatus, B. costatus, Pleurotomaria carbonaria, P. virgillati, P. sphærulata, Euomphalus carbonarius, Loxonema Hallii, Avicula orbicula, n. s., two species of *Orthoceras*, undet., *Productus splendens, P. Rogersii, P. Verneuilianus, P. semireticulatus, P. clavus? P. muricatus, Natica ventricosa, Nautilus Kentuckensis, N. globatus, N. striatus, Temnocheilus*, two species undet., *Goniatites crenistria.*

Of these species, the following have a great vertical range, viz., *P. Wabashensis, P. splendens, P. Rogersii, P. semireticulatus, P. punctatus, P. Verneuilianus, Chonetes mesoloba, Orthis crenistria, Loxonema Hallii, Euomphalus carbonarius, Pleurotomaria virgillati, P. sphærulata, P. carbonaria, Bellerophon Urii, B. percarinatus, Macrocheilus acutus, M. inhabilis*, and *Spirifer cameratus.*

The following species appear to be confined to the upper members, viz., *Spirifer Kentuckensis, Rhynconella*, species? *Spirifer lineatus, Cyathophyllum fungites, Avicula orbicula, Terebratulina pentatoma*, and *Terebratula subtilita.*

Table of Carboniferous fossils identified in the Eastern and Western Coal-fields, with Localities and Strata.

Species.	Eastern system.		Western system.	
	Locality.	Strata.	Locality.	Strata.
Spirifer cameratus, Hall,	Pittsburgh, Pa.,	Calcareous shales above the lower coal series.	Vance, Ill.,	Brecciated limestone, middle of the series.
	Coshocton, O.,	2nd limestone.	Salina, Ill.,	Upper limestone.
	Tuscarawas, O.,	" "	LaSalle, Ill.,	" "
	Greentown, O., Hall,	Lower limestone?	Pecos Villages, N. Mexico, Hall,	Coal measures.
			San Sabo Valley, Roemer, Texas,	" "
S. lineatus,	McKean Co., Pa.,	Cherty limestone middle series,	Vance, Ill.,	Brec'd limestone.
	Yellow Creek, O.,	Upper limestone.	LaSalle, Ill.,	Middle limestone.
			Pecos Villages, Hall.	Coal measures.
S. Forbeseyii,	Coshocton, O.,	1st limestone.	Burlington, Iowa,	Mt. limestone, Norwood and Prattes.
S. Kentuckensis,	"	2nd "	Springfield, Ill.,	Upper shales.
			LaSalle, Ill.,	" "
			Weston, Missouri,	Coal measu's, Hall.
			Pecos Villages, N. M.,	" " "
Rhynconella, spec.?	"	" "	LaSalle, Ill.,	Upper shales.
	Summit, Columbiana Co., O.,	Calcareous shales above the lower coals.	Danville, Ill.	Roof of coal, mid. of the series.
Terebratula subtilita,	Yellow Creek, O.,	Upper limestone.	LaSalle, Ill.,	Upper limestone.
	Coshocton, O.,	3d limestone.	Salina, Ill.,	" "
T. elongata,	Pittsburgh, Pa.,	Calcareous shales.	LaSalle, Ill.,	" "
Terebratulina pentatoma,	Summit, Col. Co., O.	" "	" "	" "
Athyris, spec.?	Yellow Creek, O.,	Hydraulic l. stone.	" "	" "
Nucula Hammeri,	Ohio river at mouth of Yellow Creek,	Upper limestone.	Danville, Ill.,	Roof of coal.
	Yellow Creek, O.,	" "	Rush Cr., Ind.,	Coal shales, J. H. McCheaney.
	Summit, Col. Co., O.	Calcareous shales.	LaSalle, Ill.,	Black shales.
Cardiomorpha, spec.?	Pittsburgh, Pa.,	" "	Springfield, Ill.,	Upper "
	"	" "	" "	" "
	Yellow Creek, O.,	Upper limestone.	Danville, Ill.,	Roof of coal.
	Summit, Col. Co., O.	Calcareous shales.	Springfield, Ill.,	Blk upper shales.
Avicula orbicula, n. s.,	"	" "	" "	" " "
Orthis crenistria,	Yellow Creek, O.,	Hydraulic l. stone.	Danville, "	Roof of coal.
Cyathophyllum fungites,	Pittsburgh, Pa.,	Calcareous shales.	" "	Middle shales.
	Yellow Creek, O.,	Upper limestone.	LaSalle, "	" "
			Centralia, "	Upper "
Cyathaxonia, spec.?	Pittsburgh, Pa.,	Calcareous shales.	" "	" "

Species.	Eastern system.		Western system.	
	Locality.	Strata.	Locality.	Strata.
			LaSalle, Ill.,	Upper shales.
Macrocheilus acutus and M. inhabilis,	Pittsburgh, Pa.,	Calcareous shales.	Danville, Ill.,	Middle shales,
	" "	" "	" "	Roof of coal.
			Springfield, Ill.,	Bl'k upper shales.
Bellerophon Urii,	Pittsburgh, Pa.,	Calcareous shales.	" "	" " "
B. percarinatus,	McKean Co., Pa.,	Cherty limestone.	LaSalle, "	Middle shales.
	Yellow Creek, O.,	Upper limestone.	Galatea, "	Coal meas., N. & P.
	Summit, Col. Co., O.	Calcareous shales.	Grayville, "	" " "
	Coshocton, O.,	2nd limestone.	N. Harmony, Ind.,	" " "
	Tuscarawas, O.,	" "	Rush Cr., "	" " "
B. costatus,	Pittsburgh, Pa.,	Calcareous shales.	LaSalle, Ill.,	Upper shales.
Pleurotomaria carbonaria,	"	" "	" "	" "
	Summit, Col. Co., O.	" "	Danville, Ill.,	Roof of coal.
P. sphærulata and virgillati,	"	" "	" "	" "
	Pittsburgh, Pa.,	" "	LaSalle, "	Upper shales.
			Rush Cr., Ind.,	Coal shales, J. H. McC.
Loxonema Hallii,	"	Calcareous shales.	" " "	" " "
			Danville, Ill.,	Roof of coal.
Chonetes mesoloba,	Mahoning Co., O.,	1st limestone.	" "	" "
	Coshocton, O.,	2nd "	LaSalle, "	Upper shales.
	Yellow Creek, O.,	Upper limestone.	Centralia, "	" "
Productus scabriculus,	Tioga, Pa.,	Iron-stone shales.	LaSalle, "	" "
	McKean, Pa.,	" " "	Danville, "	Roof of coal.
	Mahoning Co., O.,	" " "	Pine Creek, Ind.,	Lower shales.
P. splendens,	Yellow Creek, O.,	Upper limestone.	LaSalle, Ill.,	Upper limestone.
	Coshocton, O.,	2nd "	" "	Marble limestone.
P. Wabashensis,	Tuscarawas, O.,	" "	" "	" "
	Yellow Creek, O.,	Hyd. limestone.	Danville, Ill.,	Limestone below coal.
			N. Harmony, Ind.,	Coal meas., N. & P.
P. Rogersii,	" "	" "	Danville, Ill.,	Roof of coal.
			Salina, "	Upper limestone.
			Sugar Cr., Ill.,	" " J.H.McC.
			Huntsville, Mo.,	Coal measures. P.
			Pecos Vill., N. M.,	" " Hall.
P. Verneuilianus,	Pittsburgh, Pa.,	Calcareous shales.	Danville, Ill.,	Roof of coal.
	Coshocton, O.,	3d limestone.	LaSalle, "	Upper shales.
	Yellow Creek, O.,	Upper limestone.		
P. semireticulatus,	Coshocton, O.,	1st & 2d limestone.	Warsaw, "	Mt. limestone, N. & P.
			Pecos Vill., N. M.,	Coal measures, H.
P. clavus,	Yellow Creek, O.,	Upper limestone.	Grayville, Ill.,	Upper coal measures, N. & P.
P. muricatus,	Coshocton, O.,	" "	Pike Co., Ill.,	Calcareous clays "
			Richmond, Mo.,	" " "
P. equicostatus,	"	1st & 2d limestone.	LaSalle, Ill.,	Middle shales.
Natica ventricosa,	Yellow Creek, O.,	Upper limestone.	Danville, Ill.,	Roof of coal.
			Vance, "	Brec'd limestone.
Nautilus Kentuckensis,	"	" "	Danville, "	Roof of coal.
N. globatus,	Pittsburgh, Pa.,	Calcareous shales.	" "	" "
N. striatus,		" "	" "	" "
Temnocheilus, spec.?	Yellow Creek, O.,	Middle shales.	" "	" "
Goniatites crenistria,	Summit, Col. Co., O.	Calcareous shales.	" "	" "

APPENDIX.—Since preparing this article for the press, I have been favored, through the politeness of one of the editors of this Journal, with the perusal of M. Lesquereux's highly interesting report on the fossil flora of western Kentucky, in vol. iii of the Kentucky Geological Survey. Through Dr. J. S. Newberry of Cleveland, Ohio, I had previously received the main features of his theory of the formation of coal. I am very free to say, that all my explorations in the field, confirm more and more strongly this theory.

But while assent is freely yielded to the opinion, that coal beds are but the transformed peat-bogs of the Carboniferous continent, and that the beds were cotemporaneous, I cannot agree with him that they were continuous, or even in many instances

contiguous; and that the wide belts of upheaved Devonian and Silurian rocks now separating our coal-fields, were once covered with the carboniferous strata, and subsequently to the coal era, have been denuded by erosion and their debris gone to form the quarternary deposits of the Ohio and Mississippi rivers. It is true, as he well observes, that "the loam deposited by these rivers is sometimes mixed with broken and rolled pieces of coal; there are even some deposits of alluvial rolled coal, or pebbles of coal, heaped in strata in such a way that they have been taken by inexperienced observers, for true coal beds." These I would explain by far more local and circumscribed abrasions, during the drift era. Near the village of Liverpool, Ohio, similar phenomena are to be seen. These were most evidently caused, by the erosion of the valley of the Beaver River, which cuts through the entire coal strata northwards to the valley of Lake Erie, forming a deep and wide channel, through which flowed a boreal current long after the elevated plateau of the coal-fields was dry land. Through this channel and similar ones, came the gravel deposits of the Ohio bottoms,—gravel composed of all the formations from the primitive to the coal inclusive, in which is found "*drift coal.*" The marshes of Cayuga Lake and Lake Erie, and the swamps of the Atlantic shores, and the everglades of Florida are cotemporaneous, but not contiguous. Why may there not have been a similar state of things on our continent during the carboniferous era?

If I rightly apprehend M. Lesquereux, the dynamics of his theory demand an equal subsidence of the continent through all its extent, after each successive growth of peat plants, in order that the marine fauna of shallow or deep water, as the case may be, shall be found in the roof shales and other intermediate and coeval strata. I would explain the diversity of the fauna and flora, as well as the want of synchronism of the coal beds, and associated coal measures of each minor and subsidiary coal basin, by an unequal action of the forces causing subsidence, and consequently a deeper depression of some local basins than others co-equal. Hence, in some roof shales we find molluscs, peculiar to shallow and brackish waters: while in others, where stratigraphically the coal beds are of the same age, we find the relics of deep sea molluscs; and instead of calcareous shales thinly bedded, we find thick strata of limestone, richly stored with corals, crinoids, acephala and conchifera, which are evidently the exuviæ of the dwellers of deep and warm sea waters. Again, I would call in to aid in explaining the various phenomena, the different currents which may have impinged upon our coasts, or swept through the Carboniferous archipelago; some from the tropics with heated water, the favorite temperature of crinoids and corals, while others from temperate zones, would give entirely different orders and genera.

In this connection, permit me to ask,—in the abundant marine fauna observed by explorers, have we any examples of boreal or hyperborean species? Have we not negative proof in the absence of all Arctic species, that polar currents did not strike upon the Carboniferous shores. Thus we find evidence of the pre-existence of a Devonian and Silurian continent, lying northwards of the Carboniferous portion, forming a permanently separating barrier between the polar and tropical waters. The south and southwestern slopes of this continent were in a state of oscillation, and upon them were the coal measures laid down by tides, currents and other aqueous forces, just as the tertiary was added to the cretaceous, or the quarternary to the coasts of New Jersey or Long Island.

Williamsburgh, L. I., April 22, 1858.

ART. XI.—*On Schrötterite from Cherokee Co., Alabama;* by J. W. MALLET.

THE mineral which is the subject of this notice was lately sent to me, along with several other specimens, by a gentleman of Montgomery, who requested me to examine them for supposed valuable metallic contents. They were found "at or near the falls of Little River, on the Sand Mountain, Cherokee Co., Ala.," and therefore about the junction of the Carboniferous with the Silurian or Devonian rocks of that part of the state. The fragment of rock upon which the Schrötterite occurs is a dark-colored bituminous slate, probably the "black slate" which the late Professor Tuomey has considered as representing the Devonian formation in this region.

Between this rock and the mineral a white pulverulent substance, resembling kaolin, is found. The mineral itself appears as an incrustation, one-half to three-quarters of an inch in thickness, of stalactitic structure, the individual stalactites about an eighth or a quarter of an inch in diameter, closely adherent, presenting traces of a concentric arrangement, but none of crystallization. The mere surface tends to a pulverulent appearance, is dull, nearly opaque, and slightly stained with peroxyd of iron, but this does not extend so far as to form a distinct crust. The mineral when broken closely resembles *gum arabic;* it is translucent, nearly transparent, and of the lightest possible brown tint, almost colorless. Streak white; lustre vitreous, inclining to resinous; fracture imperfect conchoidal; very brittle. Hardness $=3{\cdot}5$. Spec. grav. $=1{\cdot}974$.

Heated in a glass tube, the mineral gives off water, becomes opaque and white, and, when highly heated, of a light lavender-

blue color. The water collected on the sides of the tube has a slight acid reaction. Heated alone before the blowpipe on charcoal, it becomes white and opaque, intumescing quietly; on further application of heat, darkens in color, becoming smoke-gray or lavender-blue; strongly ignited, burns white again, remaining quite infusible. With nitrate of cobalt, acquires a fine blue color. With borax and microcosmic salt, on the platina wire, dissolves easily and in large quantity, forming colorless and transparent beads, which, if much mineral be present, become milky on cooling. With carbonate of soda, fuses with much effervescence to a white porcelain-like bead; if more mineral be used, an infusible white slag is formed. Dissolves easily and perfectly in hydrochloric acid, the solution, if concentrated, gelatinizing on cooling. Becomes by strong ignition very difficult of solution in acids.

Two analyses were made of the mineral, with the following results:—

	1.	2.	Mean.	Atoms.	
Silica,	10·35	10·72	10·53	·232	1·
Alumina,	46·80	46·16	46·48	·904	3·9
Water,	41·12	41·07	41·09	4·565	19·7
Oxyd of zinc,	·74	·79	·77		
Oxyd of iron, Magnesia,	*traces.*	*traces.*	*traces.*		
Sulphuric acid,	·83	·77	·80.		
	99·84	99·51	99·67		

Hence the formula $\dot{A}l^4\ddot{S}i+20\dot{H}$.

The mineral differs essentially from schrötterite, to which the formula $\dot{A}l^4\ddot{S}i+18\dot{H}$ has been assigned, only in containing two atoms more of water; and since all the physical properties agree closely with those of the species described by Schrötter, the two may be fairly considered as identical. In the analysis of Schrötter, as I have seen it quoted, no mention is made of the temperature at which the mineral was dried, or whether it was dried at all, and the course pursued in this respect might perhaps account for the difference in the quantity of water, the material used for my experiments having been taken in its natural condition. In each of the two determinations of water, an attempt was made to ascertain the proportion lost at 100° C., but without very accurate result. The mineral begins to give off water below 100°, and at 100° pretty rapidly loses 8 or 10 p. c., but continues slowly to yield a little more for a long time at this temperature, so that, weighed hour by hour, it still at the end of twelve hours decreased in weight a few milligrams each time that it was placed upon the balance. At higher temperatures the water seems to be in the same way gradually driven off, and a bright red heat suffices for its complete expulsion. After twelve hours drying at 100° C., *about* five atoms of water (one-

fourth of that present) appear to be expelled; but as Professor Dana has observed in his comments upon allophane analyses,* this assumption of 100° as the temperature always separating essential from non-essential water is quite arbitrary, and it appers therefore desirable for the present to consider minerals of this class in their natural (air-dried) state. It would perhaps be possible to make, without great delay, such a series of experiments at very gradually increasing temperatures as should render evident some *real* separation of the water present into two or more portions, facilitating the escape of water by first reducing the mineral to powder. The formula preferred by Rammelsberg† for Schrötter's mineral, $(\dot{A}l_2\ddot{S}i+12\dot{H})+2\dot{A}l\dot{H}_3$, brings in gibbsite as a proximate constituent.

This Alabama mineral is remarkable as containing a little *oxyd of zinc*, while in Schrötter's specimens oxyd of copper was present. Small quantities of oxyd of copper also occur in almost all the published analyses of allophane, and would seem to point to oxydation of metallic sulphurets as the source of sulphuric acid, which may have afterwards taken part in the production of the allophane and allied minerals. Both in Schrötter's analyses and mine, traces of sulphuric acid itself were found.

Schrötterite having hitherto been reported from but a single locality—Freienstein in Styria—it is interesting again to find it, now in this country. I am unable to refer to the original paper of Dr. C. T. Jackson‡ upon allophane from a not very distant locality in Tennessee; it would be desirable to compare the conditions under which the two minerals occur and have been formed.

University of Alabama, March 6, 1858.

ART. XII.—*Contributions to Analytical Chemistry;* by HENRY WURTZ, of New York City.

(Read before the American Association for the Advancement of Science, at Baltimore, 1858.)

Investigation of the action of nitric acid on the metallic chlorids.—(Continued from vol. xxv, p. 384.)

29. *Cerium.*—Chlorid of cerium,§ which had a faint pink tinge due to contamination with chlorid of didymium, and probably contained also a little chlorid of lanthanum, but was other-

* Amer. Jour. Sci., [2], vol. xxiv, p. 131. † Handw. d. chem. Th. d. Min., S. 18.

‡ Proc. Bost. Soc. Nat. Hist., p. 120, 1855.

§ The cerium, lanthanum and didymium compounds used were prepared from extremely beautiful specimens of highly crystallized sulphates, for which I am indebted to the generosity of Mr. T. Sterry Hunt of the Canada Geol. Survey. The sulphate of didymium, especially, was in crystals nearly a quarter of an inch long, presenting internally a rose-colored transparency and brilliant cleavage, though the faces were ill-defined and dull, apparently from efflorescence.

wise perfectly pure, left on evaporation with excess of nitric acid a deliquescent nitrate which still contained chlorine, and the latter was not wholly expelled by two repetitions of the same treatment.

30. *Lanthanum.*—The chlorid used was also faintly tinted by chlorid of didymium, and probably not entirely free from chlorid of cerium. The nitrate, left upon evaporation with nitric acid, appeared to be much more deliquescent than the nitrate of cerium. Chlorine was retained as obstinately by it as by the latter, a trace remaining after three evaporations with nitric acid.

31. *Didymium.*—The chlorid of didymium, free from all impurities except probable traces of chlorids of cerium and lanthanum, gave similar results. The resulting nitrate (still retaining a trace of chlorine) had a violet color and was deliquescent.

32. *Thorium.*—Some perfectly pure chlorid of thorium* was decomposed with difficulty, leaving after the third evaporation with nitric acid a deliquescent nitrate, which still contained a trace of chlorine. This nitrate had a strongly astringent taste.

33. *Zirconium.*—Pure chlorid of zirconium† resisted two operations, still retaining a trace of chlorine.

34. *Molybdenum.*—Some extremely beautiful crystals of pure molybdic acid;‡ dissolved in chlorohydric acid and evaporated with an excess of nitric acid, left a residue also beautifully crystallized; containing but a faint trace of nitric acid and no chlorine. A small quantity of a *blue* substance appeared with the residue, the color of which was destroyed by nitric acid.

35. *Vanadium.*—Pure vanadic acid§ gave a beautiful green solution with chlorohydric acid, which, when evaporated with nitric acid, left a fine brown residue containing no trace of chlorine or nitric acid, and insoluble or nearly so in water, being evidently nothing but vanadic acid.

Preparations of the metals *iridium*, *palladium*, *rhodium*, *ruthenium* and *yttrium* I have been unable as yet to obtain in a state sufficiently pure to afford satisfactory results, and must therefore postpone the consideration of these, together with my general conclusions and deductions from the complete results, until a future communication.

With the chlorids of *sulphur*, *phosphorus*, *selenium*, *tellurium*, *boron*, *silicon*, *titanium* and *tantalum*, it is of course useless to experiment, for according to Berzelius, H. Davy, and others, they

* Prepared from a specimen of *orangite* (thorite) presented to me by Mr. George J. Brush, by solution in muriatic acid, evaporation to separate silica, precipitation with ammonia, solution of the washed precipitate in the smallest possible quantity of dilute sulphuric acid, precipitation of the sulphate of thoria by boiling, washing with boiling water, dissolving in cold water, precipitation by ammonia, washing and dissolving in chlorohydric acid.

† Made from some nearly pure zirconia obtained from Mr. T. Sterry Hunt.

‡ From Mr. Brush. § From Mr. Hunt.

are all readily converted by contact with water alone, either into the corresponding oxyds, or into combinations of chlorohydric acid therewith which are very unstable and decomposed by evaporation alone. *Osmium* also, according to H. Rose,* is converted by nitric acid into osmic acid, and even by *aqua regia*, no chlorid of osmium being formed in the latter case. The chlorids of *columbium* (pelopium,† niobium,‡) according to the same authority, are immediately and entirely decomposed by water into the corresponding oxyds and chlorohydric acid. So also, according to Woehler, with the chlorids of *tungsten*.§

In addition to the unsuccessful attempts alluded to in the first part of this paper to expel all the chlorine from sesquichlorid of iron by nitric acid in conjunction with the deutoxyds of lead and manganese, two others were made, using permanganic acid and chlorate of potash instead of the deutoxyds. On adding to the chlorid nitric acid and a little chameleon mineral, and evaporating to dryness, the residue still contained chlorine, and after a repetition of the same treatment, a trace was still found. With chlorate of potash, however, a successful result was obtained; the residue contained no trace of chlorine.‖

Separation of magnesia from the alkalies.

The only further results of this investigation in condition to be presented are those of some experiments to test quantitatively the separation of magnesia from the alkalies by evaporating the mixed chlorids with nitric acid, decomposing the resulting nitrates by heat, and dissolving out the potash and soda with water. For these experiments the following preparations were made:

Chlorid of sodium, by supersaturating pure carbonate of soda with pure chlorohydric acid, recrystallizing and fusing the product.

Chlorid of potassium, by recrystallizing some chlorate of potash, washing with cold water, drying, and fusing carefully and for a long time in a platinum crucible.¶ The chlorid thus obtained still retained, however, a trace of chlorate or perchlorate, for when dissolved in chlorohydric acid and boiled with a little indigo solution, bleaching took place. To test its purity therefore 0·5809 gram was dissolved in water and evaporated to dryness with an excess of pure chlorohydric acid. The residue

* Ausführliches Handbuch der anal. Chemie, i, 218.
† Ibid., i, 299. ‡ Ibid i, 307. § Gm. Handbuch, ii, 476 and 477.
‖ When water was poured on the residue, a violet or amethyst color appeared, probably due to a small quantity of *ferrate* of potash.
¶ In this operation it is necessary to project the chlorate into the crucible in very small quantities at a time, waiting until each preceding portion is entirely decomposed, as the decomposition is very violent and accompanied by great frothing.

weighed 0·5814 gram, and no longer bleached, thus showing the contamination to be unimportant.

Chemically pure *magnesia*, by igniting the pure nitrate very strongly, pulverizing the residue very finely, and washing for a long time. During the washing it absorbs carbonic acid rapidly, cakes together and forms a very hard mass resembling porcelain biscuit, so that in order to continue the washing it is necessary to pulverize it again. It was finally ignited very strongly again. Prepared in this way, magnesia is a dense heavy powder, of extreme whiteness. 0·4755 gram gave 1·2854 of pyrophosphate of magnesia, corresponding, when Schroetter's equivalent for phosphorus (= 31) is adopted, to 0·4362 of magnesia, or only 97·40 per cent of the quantity taken, the 2·60 per cent of loss being apparently due to the solubility of the ammonia-phosphate in the dilute ammonia used for washing it. Calculated upon the old equivalent of phosphorus (= 31·32) however, the determination gives 0·471 of magnesia = 99·05 p. c., a very fair result. 0.42 gram of the same magnesia was dissolved in chlorohydric acid, the chlorid converted into nitrate by evaporation with excess of nitric acid in a beaker glass, the residue transferred to a platinum crucible, dried and ignited. The residual magnesia weighed 0·4192 gram = 99·81 per cent.

0·4392 gram of the above magnesia was then taken, dissolved in chlorohydric acid, mixed with 0·6907 of the pure chlorid of potassium, and 0·9946 of the pure chlorid of sodium, water added sufficient to dissolve the chlorids, then an excess of nitric acid, and the whole evaporated to dryness in a beaker glass on the sand-bath. The complete conversion of the chlorids into nitrates may be ascertained with the utmost readiness in these operations, by the disappearance of the yellow color which the liquid assumes during the evaporation, and which it retains so long as any chlorohydric acid is present. When this color no longer reappears on adding a few drops of strong nitric acid to the hot liquid, all chlorine has certainly been expelled. The vapor from the liquid also, so long as chlorine is present, will bleach litmus paper powerfully.

After expulsion of the chlorine, the liquid was transferred to a large platinum crucible, and evaporated on the sand-bath until the residue was syrupy in consistence. Some caution is necessary during the latter part of this evaporation to prevent spattering. The cover was then placed loosely on the crucible and a high sand-bath heat applied. Red gas was evolved for a considerable time with effervescence until finally the mass solidified. On applying a gentle lamp heat, however, it again fused, and evolved red gas anew with effervescence. My object being to convert the alkalies into carbonates, a piece of platinum foil was placed in the crucible, on which was laid a lump of carbonate of

ammonia. Under these circumstances the decomposition proceeded rapidly, and the mass soon presented an appearance of tranquil fusion, with much white sediment, and evolved no more gas. The heat was finally raised to redness for some minutes. On cooling, hot water was added, the solution diluted and thrown upon a filter, together with the washings of the platinum foil and crucible cover; these, together with the crucible itself, being put aside for further use, it being found that a small quantity of the magnesia remained adhering to them. The mass remaining on the filter was washed with boiling water, and the filtrate, which had a strong alkaline reaction, heated in a beaker glass to boiling, and a current of carbonic acid gas passed through, to ascertain whether any magnesia was still held in solution. After a long time a very minute precipitate appeared, but at the same time the liquid became loaded with flitters of silica, proceeding from action of the solution of alkaline carbonates on the glass, and a slight error was thus introduced into the result. The filter with the magnesia was burned in the same crucible, the combustion being found surprisingly easy, and the magnesia weighed 0·44 gram. The precipitate obtained by the carbonic acid (with intermixed *silica*, as well as some *lime*, afterwards found in it, derived also from the glass) weighed half a milligram, making the whole product weigh 0·4405 gram, against 0·4392 taken. On dissolving the product in chlorohydric acid, the silica remained behind as a very perceptible residue, and the solution contained also a distinct trace of *platinum*, although the loss of the crucible during the operation was not more than one fifth of a milligram. In these processes, however, it would seem better to use a silver crucible.

In the above experiment no attempt was made to determine the alkalies in the filtrate, but the result with the magnesia being unexpectedly successful, for a first attempt, another experiment, with this in view, was proceeded to. 0·3627 gram of magnesia, 0·6092 of chlorid of potassium, and 0·816 of chlorid of sodium were taken. The mode of proceeding was the same as before, except that the application of the carbonate of ammonia was longer continued, and after the decomposition of the nitrates, the mass was dissolved in hot water, a feeble current of carbonic acid passed through the liquid *while still in the crucible*, and the latter heated on the sand-bath for an hour before filtering. The filtrate was supersaturated with chlorohydric acid, evaporated to dryness, the ignited residue weighed, the chlorine determined as AgCl, and the proportions of the two chlorids calculated in the usual manner in indirect analysis. The results were 0·3631 of magnesia, 0·607 of chlorid of potassium and 0·8111 of chlorid of sodium.

The separation of magnesia from the alkalies in this way may therefore be considered as an accomplished fact, and I venture to think that this mode possesses points of convenience and elements of accuracy rendering it preferable to any of those now in use. For *qualitative* analysis, and particularly for those cases in which it is desirable to combine a qualitative and a quantitative analysis in the same operation, it is particularly convenient. To *mineral analysis* also, it seems to me to be especially applicable. Use and experience will of course increase its reliability and precision, and another communication will be presented on the subject. In conclusion I may remark that similar methods promise to be applicable in numerous other cases in which metallic oxyds are to be separated from the alkalies, at least when these oxyds or their carbonates are insoluble in alkaline carbonates, and their nitrates decomposable by heat, or the vapor of carbonate of ammonia. Such bases are lime, baryta, strontia, zirconia, yttria, thoria, and the oxyds of iron, zinc, cadmium (?), copper (?), cobalt, nickel, lead, cerium and bismuth (?).

When a comprehensive investigation in which I am now engaged, having for its object to ascertain precisely the action of *heat* upon all the metallic nitrates, shall have been brought to an end, it will be possible to pronounce more definitely upon some of these cases.

Art. XIII.—*Geographical Notices.*—No. II.

Old ocean routes between England and North America.—D. J. G. Kohl, whose historical investigations in respect to the progress of discovery on the coast of the United States have been for some time in progress for the archives of the Coast Survey, has lately been publishing in the National Intelligencer (Washington, April 13 and 22, and May 1,) a series of articles on the old ocean routes between Europe and America. The subject presents many difficulties, but in the extended researches made by Dr. Kohl, much that is of value has been collected.

We append a brief statement of the routes which he discusses. In respect to each, particular information is given, which illustrates the progress of knowledge in respect to the oceanic winds and currents.

1. *The first sail from Spain to America through the region of the northeastern trade-winds, and the first home voyage from America to Spain through the region of the variable or westerly winds.* Columbus, 1492.—Under this head the remark is made that "Columbus from the outset settled the principal questions of the navigation of the central Atlantic Ocean; discovered its two

great features, the region of easterly winds, gently conducting from the Old to the New World, and the region of variable and principally westerly winds, useful for the return; and traced at once the route as well of the out-voyages as of the home-voyages of the Spanish vessels, which for a long time after him, though of course with some modifications, followed his tracks."

2. *The first Voyage from England to North America.* THE CABOTS, 1497.—The loss of papers which Sebastian Cabot wrote in respect to his voyages causes an unfortunate gap in the history of maritime discovery.

3. *The first Voyage from Portugal by way of the Azores, to Newfoundland and Labrador and back.* CONTEREAL, 1500–1.—Though the authorities on this navigator are few and vague, it is "pretty certain that his oceanic track lay between the Azores and the northern Capes of Newfoundland—that is to say, across the eastern region of the Gulf Stream, and the northeastern parts of the great Newfoundland banks."

4. *The Discovery of the Navigation of the Gulf Stream and Great Reform in the System of Spanish-American Navigation.* ALAMINOS, 1519.—"Alaminos was the first who circumnavigated the region of the trade-winds *with the greatest possible northwestern bend*, and, moreover, with the assistance of the Gulf Stream, which was unknown to Columbus and his immediate successors. Alaminos pointed out a perfectly new oceanic route, the very best and the only good one; which the Spaniards afterwards used for their return to Europe from the West Indies. Soon after him all the Spanish vessels, all the Spanish treasures from the islands, from Mexico, from Northern South America and even from Peru, went that way; and the eastern gate of the Gulf of Mexico, thrown open by Alaminos, became the principal outlet not only for this gulf, but also for the entire Mediterranean waters of America. The windward passages between the islands were now used only as *inlets* to these waters from the east. The immediate consequences of this voyage of discovery of Alaminos may be summed up thus: A better knowledge of the importance of the Gulf Stream, and of all that section of the Atlantic through which it passes; the early discovery afterward of the Bermudas; the quick rise of the harbor of Havana, which was situated at the very border of the Gulf Stream, and in the very mouth of that gate; a total change in the system of the Spanish-American navigation, and the organization of what the Spaniards called 'La Derrota de la Vuelta de las Indias,' (the return route from the Indies)."

5. *The first great French Expedition to the West, out by way of the Trade Winds, and home by way of Newfoundland.* VERRAZANO, 1524.—The Florentine Verrazano, starting from Madeira, favored by the northeasterly trades, sailed directly across the Atlantic

in about lat. 26° N. In the longitude of the Bermudas he deviated to the northwest, and reached the coast somewhere near Cape Fear, making the traverse in 49 days. "From his landfall Verrazano sailed northward along our east coast, exploring it in its whole length as far as Nova Scotia or Newfoundland," and thence returned to France by an already known route.

6. *The first traverse of the central parts of the Atlantic, from France to Florida.* RIBAULT, 1562.—"He determined to follow *a new ocean route*, which had not been attempted yet. He tells us that he struck from France at once into the broad Atlantic, and followed a more or less western course, which is, as he says, "the true and short course that hereafter must be kept to the honor of the French nation, rejecting the old conserved opinion, which so long time has been believed true:" that for reaching any part of North America, south of Canada, it was necessary to enter the trade-winds by way of Madeira and the Canary Islands. He however, unfortunately gives us no further details about the direction of his track. All that we learn about it is, that setting out from Europe westward, he saw no other coast or islands on the way, and made his landfall in about 30° north latitude, near our present St. Augustine harbor.

It is therefore very probable that he kept his course through the waters of the Azores and Bermudas. He may have passed through some regions of the ocean which never had been seen by any navigator before him. On the home track (from west to east) these central parts of the North Atlantic had been already traced by Columbus, Alaminos, and others. *But we know of no outward voyage (from east to west) which was attempted in the same direction and latitude before Ribault.*"

7. *Introduction of an important change and extension of North Atlantic Navigation by the English.* HAWKINS, 1564–5.—"Captain John Hawkins may, with full justice, be pointed out as the English discoverer of the coasts, islands, and navigation of the West Indies. All the subsequent English expeditions to America are connected with his voyages, and a host of English ships followed in his track." Three of his voyages are especially noteworthy. The first was in 1562, on which "he went beyond the Canary islands, traversed the ocean, and skirted along the northeastern coasts of the West India Islands, from which he returned to Europe by way of the sea of the Azores." On his second voyage (1564–65) he first procured a cargo of slaves on the coast of Africa, then crossed the ocean, entered the Caribbean Sea, and sailed along the south side of the Antilles, till on reaching Cape San Antonio de Cuba, easterly winds drove him into the Gulf of Mexico as high as 27° N. lat. From there he fell back to the south, rounded the Tortugas into the Strait of Florida, and, having unsuccessfully attempted to make Havana,

came in sight of the Florida Keys. Coasting thence northward to the mouth of the St. Johns river (Riviére Mai), he visited the little colony of Ribault there situated, then bore away with the Gulf Stream to the northeast, and about a month after arrived on the banks of Newfoundland, and in three weeks more reached England. His third voyage (1567–68) added to the result of his second a more thorough exploration of the Mexican Gulf. We may say, in fine, that Hawkins holds the same position in the history of English-American, as Diego de Alaminos does in that of Spanish-American navigation; the route that he pointed out became the highway for English trade and English conquest in, to, and from the New World.

8. *First consultation in England about the question, if a southern or northern voyage to the central parts of the east coast of North America would be preferable, and first attempt of a northern route.* GILBERT, 1583.—This attempt was made by Sir Humphrey Gilbert. Commanding five vessels, he ordered them to try to make Cape Race, keeping as near as possible to 46° N. lat. After a most unpropitious voyage he made land in 51° N. lat., whence he coasted southerly as far as Sable Island, (the Isle of Sablon), where the loss of his principal vessel obliged him to return. "This is the first time that authentic history shows us a navigator setting out on this now usual route from Europe for the coasts of our present United States with the pronounced conviction that it must be the best route."

9. *The First Routes of the English navigators to Old "Virginia" or North Carolina.* From 1584–1602.—The disastrous result of Gilbert's expedition brought this route into bad odor with his cotemporaries, and, this together with the more genial climate, the chance for taking Spanish prizes and sacking Spanish settlements, induced all the early Virginia voyagers—such as Raleigh, Amadas, Barlow, Mace and others—to take a southern route, reaching the West Indies about Dominica island, sailing thence along the whole chain of the windward islands, the Antilles and Bahamas, making the continent about Cape Fear, then doubling Cape Hatteras to Roanoke. By some the strong current of the Gulf Stream was thought to offer an insuperable objection to the northern route.

10. *Discovery of a more direct route from England to the North parts of Virginia, (New England).* GOSNOLD, 1602.—Bartholomew Gosnold, bearing in mind the voyage of Verrazano undertook a direct westerly route about the 40th degree of N. lat., to the shores of Virginia—the harbors of Newport and New York—and after an unfavorable passage made his landfall in 43° N. lat. This gave the cue to succeeding English navigators and became *the beaten track* to Virginia. But to us, the great interest of his journal (printed in 1602) lies in his soundings along the

North Virginian (New England) coast, and his observations on the Gulf Stream. He was greatly astonished at this warm ocean river, observed its direction and expansion towards the northeast, and calls it with great truth "a matter to set some subtle invention at work."

11. *On what route the French arrived at La Cadié, (Nova Scotia,) and the country of Arambec, (New England,) at the beginning of the seventeenth century.* DEMONTS, 1604.—It is only necessary to observe "that we find them at this time on *the true and shortest ocean route from Europe to our coasts,*" the same route which Gilbert had proposed, and more correct because more northerly than that introduced by Gosnold.

12. *First Routes from England to Chesapeake Bay.* NEWPORT, 1607.—Capt. Christopher Newport was the first who ever sailed *with a special destination* for "the Bay of Chisiapiacke." He, and his immediate successors imitated him in this—went some 20° of latitude out of his way, running southward to the Canaries, then crossing to the windward islands, whence he coasted north to the mouth of the bay. Why he did so, remains a question, the more difficult to answer, as Capt. Gosnold accompanied him.

13. *Discovery of the "Ready Way" from England to Chesapeake Bay.* ARGALL, 1609.—Capt. Samuel Argall was the first who shortened this tedious route. His course is not exactly known but "it is nearly certain that he went by way of the Azores and north of the Bermudas." In a colonial letter of this date we read that his ship had been sent out from England "to goe the *ready way,* without tracing through the torrid zone, and shee performed it."

14. *First official instruction to go by a shorter route to Virginia: Official Instructions, &c., given to a large fleet in England.* SOMERS and GATES, 1609.—These were "to leave the Canaries one hundred leagues to the eastward at least and to steer directly for Virginia, without touching at the West Indies." Little is known how they were fulfilled. The fleet of nine vessels was broken up and partially destroyed by "the tail of a West India hurricane," and no satisfactory accounts preserved for us.

15. *Lord Delaware piloted through the central parts of the Atlantic from England to Virginia,* by Captain ARGALL, 1610.—Argall did this "by way of the Azores," as we learn from Lord Delaware himself. From these islands to Cape Henry occupied seven weeks,—an unusual time, and probably to be imputed to head winds. This route was not liked nor generally adopted at once.

16. *The Tracks of the First Voyages to and from the Harbor of New York, from and to the Netherlands, at the beginning of the Seventeenth Century.*—Juan Verrazano was the first European naviga-

tor who entered New York harbor. This he did from the southwest, in the year 1524. The year after Estevan Gomez came to it by chance from the northeast, and it was not visited again till 1609; when Henry Hudson thoroughly explored it, in the notable Dutch ship, Haalve Maan. The track of his return voyage, —east-southeast to latitude 30° 30′ north, then direct to England, —"may be considered as the first direct home route from New York to Europe ever performed by an European navigator." In the days of the Manhattan settlement the dutch skippers bound for New Amsterdam usually "laid their course for the Canary islands, whence they stretched across the Atlantic towards Guiana and the Caribbees, and then ran obliquely to the northwest, between the Bahamas and Bermudas until they made the coast of Virginia," usually occupying about seven weeks.

DOVE ON THE COMPARATIVE TEMPERATURE OF THE AIR AND SEA.—Prof. Dove has lately published,* with comments, tables of the temperature of the air and water, derived from observations made at Doberan and Copenhagen, on the Baltic, and at several seaports in Ireland.

The tables indicate that the excess of the warmth of the sea above that of the air is greatest in November, and that the greatest relative cooling of the sea occurs in Doberan and Ireland in May, in Copenhagen in April and May.

On the coast of Ireland throughout the year the temperature of the sea is higher than that of the air, while the water of the Baltic from March to the beginning of July is colder than the air, a fact pointing to the well known influence of the Gulf Stream.

The remarkable fact, which is brought out, that the average temperature of the water through the year is higher than that of the air, shows that the sea is a source of warmth. Two reasons, says Prof. Dove, can be assigned for this. Since the temperature of the earth everywhere upon land diminishes materially the deeper we go, the bottom of the sea would have a much higher temperature if it lay as far under a solid surface as it does under a fluid. But since it has not this higher temperature it must have given it up. As now on the surface of the sea, the cooled drops becoming heavier sink to the bottom, they take away by contact its warmth and bear it to the top, being dispossessed by new colder sinking drops. Besides this, the motion of the sea may be considered a source of warmth, since recent experiments establish that by the friction of fluids heat is generated,—which explains a fact, recognized on all sea shores, that after a storm-shaken sea the water feels warmer to the bather. However this may be, the excess of the warmth is important

* Zeitschr. für allgem. Erdk., 1858, p. 60.

enough to demand that it should be established by continued observations how far it is general, and how far limited to particular localities.

PACIFIC RAILROAD SURVEYS.—The seventh volume of the Reports of Surveys upon the Pacific railroad routes has recently been distributed, and the eighth is reported as ready for publication.

The seventh volume contains a report of explorations made between San Francisco Bay and Los Angeles, California, west of the Coast Range, and also between the Pimas Villages on the Gila River to the Rio Grande, near the thirty-second parallel of north latitude. This survey was conducted by Lieut. J. G. Parke of the Topog. Eng., assisted by A. H. Campbell. The volume also contains a geological report by Dr. Thos. Antisell, who accompanied the expedition, and a botanical report by Prof. John Torrey, beside several appendixes. At the close of the volume a resumé of the progress of all the Pacific railroad surveys is made by Capt. A. A. Humphreys, Topog. Eng., from which we abridge the following account of Lieut. Parke's expedition.

"The survey was commenced at San José, California. The route lay through the Santa Clara, or San José valley, to the Pajaro river; down the valley of the stream to near its entrance into the bay of Monterey; around the foot hills of the Gavilan range of mountains to the Salinas plains and the valley of the Salinas river, and up the Salinas river to Santa Margarita at the base of the San Luis pass. Thus far, no material obstacles were presented to the construction of a railroad; the Santa Clara valley and Salinas plains affording a peculiarly favorable location for it. A month was devoted to a thorough examination of the headwaters of the Salinas river. Reconnoitering parties were sent forward to examine the main stream and its largest tributary, the Estrella and the Cuyama plain, or valley of the Rio de Santa Maria, beyond, while a detailed survey of the San Luis pass was being made. The explorations about the heads of the Salinas and the Cuyama plain prove that a line through this country would be impracticable. An extensive basin was discovered—the Llano Estero—a tributary to the Tulare valley, which affords a very favorable pass from that valley to the bays of Monterey and San Francisco; the elevation of the summit being about 1,800 feet above the sea. The approach from the Tulare valley is over a plain for about forty miles. The distance from this pass to Kern lake is sixty-five miles. The elevation of the lake above the sea, according to Lieutenant Williamson, is three hundred and ninety-eight feet. The route was continued across the Santa Lucia mountains, through the San Luis pass, to the seashore. A detailed survey of this pass was made. It is a sharp dividing ridge, composed of slightly metamorphosed sand-

stone and serpentine rock. The elevation of the summit was found to be 1,556 feet above the sea. It is proposed to tunnel this pass for three-fourths of a mile, commencing at a point about 200 feet below the summit. The examinations in the vicinity of San Luis Obispo having been completed, the region lying between the ocean, the plains of Los Angeles, the western edge of the Great Basin, and the heads of the Tulare and Salinas valleys was thoroughly explored. The line adopted as most favorable commences at the Arroyo Grande; traverses the Gaudalupe Largo; ascends the Todos Santos summit; descends to the Rio de Tres Alamos; crosses the spur between Rio de Tres Alamos and the Santa Inez river; passes to the summit of the Gaviote pass at Santa Cruz—elevation, 700 feet—and, through the lower portion of the Gaviote pass and creek, to the coast. From Gaviote creek to San Buenaventura, the route is near the shore. It then follows the Semi plain and pass to the San Fernando plain. The Semi pass divides the San Fernando plain from the Santa Clara plain. The San Fernando and Los Angeles plains are separated by a narrow valley.

"The examinations of the coast route having been completed, the Mojave river and basin were explored and found to have no connexion with the Colorado river and basin.

"Proceeding to the Pimas villages, the initial point of the last reconnaissance, a division of the party was made; one half proceeding, via Tucson, San Xavier, and the Cienega de los Pimas, to the river San Pedro, and the other up the Gila and San Pedro valleys. In his report of 1854, Lieutenant Parke suggested the probability of finding a feasible route from Valle del Sauz to the Gila valley by passing between the Chiricahui mountains and Mount Graham, and continuing thence in a northwesterly direction, along the western base of Mount Graham to the Gila. His views in this respect were fully confirmed by the examinations of the division of the party retained under his own command. Following the Gila river to the mouth of the San Pedro, a favorable route was found for nearly the entire distance. The valley of the San Pedro proved to be wide and open; presenting no impediment to a rail or wagon road. There was an abundance of water, grass, and excellent soil, but no growth suitable for timber, though sufficient for fuel. Twelve miles from the mouth a large tributary was encountered, coming in from the east, and a party was organized for its examination. This party, descending the San Pedro for 35 miles from the Quercus cañon, crossed the mountains on the right bank to the plains west of Mount Graham, and pursuing a northwesterly course for 36 miles, found the head of the "Aravaypa" as the newly discovered stream was called. The springs mentioned by Nugent, in his notes of Hay's trip, were found in the Playa de los Pimas, and a reconnaissance was made of Nugent's pass.

The main detachment passed through the Puerto del Dado and the smaller through the wide pass, (Railroad pass,) between the Chiricahui mountains and Mount Graham; the two uniting on the Rio Sauz, about fifteen miles below the Cienega. Examinations made eastward, across the Peloncillo (Sugar Loaf) mountains, resulted in the discovery of an excellent pass for a railroad in a more direct line than that of the route of 1854. From this range of mountains an easterly course was pursued, and connexion made with the former survey about fifteen miles west of the point where Colonel Cooke's emigrant road diverges to the southwest."

AUSTRALIAN EXPLORATION.—The Athenæum for March 13, 1858, contains a letter from Capt. Freeling, Surveyor General at Adelaide, in respect to the explorations undertaken in the central part of Australia to determine whether a navigable inland sea existed there, as has been supposed. No water was found on which a boat would float. "I was away," says Capt. Freeling "more than two months, and during that time must have travelled 1,000 miles, and I verily believe that there is no other country in the world where so much barren land exists in a similar space: it is really wonderful to see the masses of stone which lie on the hills and plains as on a newly Macadamized road, as well as the absence of grass in places where the stones are not so thickly spread; but all this barrenness may easily be accounted for by the fact that but little rain falls to promote fertility. Occasionally as in March of this year, an extraordinary rain-fall occurs; then the creeks, which are for years together dry, pour down an amazing volume of water, flooding the lands in their neighborhood and eventually discharging themselves over a vast slightly hollowed plain, which then has all the appearance of a large inland sea. Test it, however, as I did by walking three miles into it, and you then see its true character, and are able to state positively that the summer heats will not have continued long before the whole is evaporated."

NEW DIVISIONS OF THE REPUBLIC OF NEW GRANADA.—By a Law of June 15, 1857, for the old division into Provinces (*Distritos* and *Cantones*) a new division into eight states (*Estados*) is substituted, with the following names and capitals: PANAMA, (Panama), BOLIVAR, (Cartagena), MAGDALENA, (Santamarta), SANTANDER, (Pamplona), ANTIOQUIA, (Antioquia), BOYACÁ, (Tunya), CUNDINAMARCA, (Bogotâ), CAUCA, (Papayan).

The outlines of these divisions are given in a chart by Kiepert, published in the *Zeitschr. für allgem. Erdk.*, (Jan. 1858.)

VENEZUELA—The Edinburgh New Philosophical Journal for April 1858, contains a brief report of an Expedition undertaken to explore a route by the Rivers Waini, Barama and Cuyuni, to the gold fields of Carabal and thence by Upata to the river Orinoco, by W. R. Holmes and W. H. Campbell.

UNITED STATES SURVEY OF THE COLORADO RIVER.—A letter from one of Lieut. Ives's party, now engaged in the survey of the Colorado River gives the following particulars in respect to the Expedition.

"Lieut. Ives has carried a minute hydrographic survey from the mouth of the Colorado to the mouth of the Rio Virgen, where the road to Salt Lake City approaches nearest the river. We are now descending the river to meet the mule train and to commence the survey of the upper Colorado, Virgen, etc., with the land party.

Our explorations have demonstrated the fact of the navigability of the Colorado to the mouth of the Virgen, a point far above that ever reached by any other exploring party—and the much-talked-of and much-dreaded 'Big Cañon' has been passed through in safety. Although the navigation of the river became more difficult as we approached within 60 or 70 miles of the mouth of the Virgen, we encountered no insurmountable obstacles even at this unprecedently low stage of the water, and there is now no question that with the quantity of water which flows in its channel during most of the year, and with steamers adapted to its navigation, the Colorado will afford the most feasible route for transportation of men and supplies to the region around Salt Lake. We hope to finish our land survey in three months."

MEXICAN BOUNDARY SURVEY.—The first volume of the Report of Major Emory on the Survey of the Boundary between the United States and Mexico made under the direction of the Secretary of the Interior has recently been published in a quarto form, fully illustrated. The whole work consists of two volumes divided into four parts. The first part consists of the personal narrative, general description of the country, journal of the joint commission, the astronomical work, barometrical levels, meteorological record and magnetic observations. The second part consists of the geological researches with annotations and a review of the whole by Prof. James Hall. The third part comprises the general botanical features of the country by Dr. John Torrey described from memoirs of the assistants and from the plants themselves, and a separate description of the Cactaceæ by Dr. George Engelmann of St. Louis. The fourth part embraces the natural history of the country by Prof. Spencer F. Baird based upon the notes of the assistants and the specimens themselves.

The volume now published contains a general map on a scale of 1 : 6,000,000, and other sectional maps of the boundary line and adjacent territory on a scale of 1 : 600,000—are hereafter to be given. D. C. G.

Yale College Library, June 7, 1858.

Art. XIV.—*On the genera Orbulina and Globigerina of d'Orbigny;* by L. F. Pourtales.

Hitherto the two genera of Foraminifera established under the names of *Orbulina* and *Globigerina* by d'Orbigny had been widely separated in the classification; he had even put them in different orders, although he had remarked the similarity in the structure of the shell. Ehrenberg also places them in different families (the former under the name of *Miliola*), but marks the two genera of Miliola and Gromia as doubtful, and appends to the characteristics of the family of *Miliolina* the query, "*An status juvenilis reliquorum?*" M. S. Schultze makes of *Orbulina* a family among his *Monothalamia*, whilst *Globigerina* is included in a subfamily of the family of *Turbinoida* among the *Polythalamia*.

I think I am now able to show, by numerous preparations, that these two supposed genera are only different stages in the cyclical or alternate generation of the same species. Having had an opportunity of examining large numbers of well preserved specimens obtained from the bottom beneath the Gulf Stream by the U. S. Coast Survey, and entrusted to me for examination by Prof. Bache, Superintendent, I have found in nearly one-half of the Orbulinæ examined, young Globigerinæ more or less developed and attached to the inside of the Orbulina by numerous very slender spiculæ. Only one Globigerina is developed in an Orbulina, whose cavity it gradually fills up, and whose shell it finally bursts to make its escape. At that time the Globigerina has already nearly attained its full size, and I have counted as many as sixteen cells in a specimen having yet room for several more before filling up the parent Orbulina.

How the Orbulina-form is reproduced I have not yet traced out. None were noticed of very small size among those examined. Large individuals are frequently found containing a smaller one filling the cavity exactly; the old shell is finally cast off, and appears to remain attached in fragments to the young one for some time. I am unable to say as yet whether this is to be considered as an act of reproduction, or merely as a renewing of the shell. It is not rare to find Orbulinæ with this double shell, containing already a young Globigerina.

I hope to be able to follow out the whole chain of development of these beings; but the above facts have appeared to me interesting enough to be at once communicated.

ART. XV.—*Correspondence of J. Nicklès, dated Paris, Feb.* 28, 1858.

Electricity, by A. de la Rive.—The third and last volume of this remarkable work has just appeared after a delay of two years, caused by the necessity of studying up the applications of electricity in special directions, and therefore of acquiring knowledge in other departments. Thus the applications to medicine have compelled him to acquaint himself with physiological phenomena, and the physical applications, to become versed in the details of practical mechanics.

This third volume commences with a profound study of electricity in its relations to natural phenomena. Commencing with the physiological actions of animal or vegetable origin—he then passes to atmospheric electricity—then to terrestrial magnetism, its causes and the attendant phenomena, among which comes the Aurora Borealis, an effect according to De la Rive, of the action of electricity on terrestrial magnetism.

As to the causes of terrestrial magnetism, the author seems to adopt, with Secchi, the theory propounded by us on this subject in 1844, and brought out in this Journal in 1853.* The cause, according to this theory, resides in the sun, which acts upon the earth as in the ordinary experiment by rotation a magnet acts upon a body having a rotating movement. But whence the magnetism of the sun? The reader will find our views on that subject in the volume of this Journal just referred to.

The remainder of this volume is occupied with the applications of electricity, mechanical, physical, chemical and physiological. De la Rive has let nothing of interest escape his attention; and with the aid of his son, he has brought the whole into the plan of his work.

On the pretended formation of Urea by the oxydation of albuminoid substances.—In our correspondence of November, 1856, we announced a very important observation which to-day is contested—the transformation of proteine substances and especially of the white of an egg, into urea, through oxydation by means of Mn^2O^7KO. Mr. Staedler, Professor of Chemistry at Zurich, in repeating the experiment of Mr. Béchamp with great care, has in fact obtained a crystalline substance precipitable by oxalic acid and by nitrate of mercury; this substance was benzoate of potash, proceeding from the albumen and permanganate of potash employed. The cause of Béchamp's error, according to Prof. Staedler, is connected with the characters just mentioned based one on the feeble solubility of the displaced benzoic acid, and the other on the insolubility of benzoate of mercury.

Natural Diapason.—Mr. Cagniard-Latour, one of our principal acousticians, has satisfied himself that he hears the sound *la* of the musical scale sounding within his head when he agitates it from side to side; and Mr. Jobard has confirmed this observation in himself, and asserts that any one can verify it, if he will disembarrass his neck of the cravat and collar and place himself apart from all noise.

Mr. Jobard thus explains the fact. This natural *la* is caused by the contact of the *malleus* against the *incus* in the ear—a contact easily

* This Journal, xvii, 116, xviii, 386.

made by a rapid movement of the head. Mr. Jobard goes still farther: for according to him, those persons who, on shaking the head, hear two *la* in perfect unison are born musicians; they have the voice and ear perfectly correct. But those that hear *la* only in one ear, have an imperfect appreciation of sounds; and those who perceive two different sounds, the *la* and another note, not only do not love music, but detest and avoid it; and he proposes by this method to discover among young people those who may become musicians.

Mr. Jobard has still under enquiry, whether the note which is produced in the head by a quick motion is the same or not in all persons. The question will be of difficult solution; for the reader may remember some remarks in our correspondence of the 30th of June, 1855,* on the subject of normal diapason, showing that the *la* of the opera of Paris is different from that of the theatre of Strasbourg, Lille, Vienna and London, and that this *la* is becoming more and more elevated, so that in twenty years it will correspond to many more vibrations than now and be therefore still more acute.

Motor for the trains of the Submarine Tunnel.—Although political events in France have turned attention somewhat from the gigantic project with which we have entertained the reader in our last communication, the project still makes some progress, and its author, Thomas de Gamond, has nearly perfected his plans. The question however comes up—what kind of locomotives will be used. If steam be employed, how will ventilation be accomplished so as to keep the air respirable and rid it of the deleterious gases, carbonic acid, carbonic oxyd, sulphurous acid, and sulphuretted hydrogen, generated by the locomotive?

If the difficulty of driving air into tunnels, explained in a former communication,† be considered, it will be strongly doubted if ventilation can be thus accomplished without great cost. In order that the air should be fit for man it should not contain over *five* parts of carbonic acid in a *thousand*, especially when the oxyd of carbon is added to it. But ten trains of passengers by day and as many of freight by night would soon render the air irrespirable; for notwithstanding the great extent of the tunnel, forty-seven kilometers, the destructive condition would soon be reached—the interior capacity of the subterranean passage being only 2,324,385 cubic meters.

Foreseeing that the methods of aeration which might be used for this end would be insufficient, and considering too that the problem will not be met by substituting an electro-magnetic machine (supposing the power could be thus obtained) I propose to employ a *machine with compressed air*—which will supply

First—the motive power.

Secondly—the air necessary for use.

The experiments of Mr. Andraud and those of Mr. Julienne have been made on a scale so large as to place beyond doubt the feasibility of using compressed air for locomotion. By their experiments we know that with 1 cubic meter of air at 8 atmospheres (that is, 8 cubic meters reduced to 1), the power is obtained of transporting on rails a charge of 15 tons to a distance of 1 kilometer. A train of cars of 200 tons will then require

* This Journal, xx, 262. † This Journal, vol. xxv, p. 96.

13·3 cubic meters of air at 8 atmospheres to run over one kilometer of road; and 625 c. m. to pass the length of the tunnel. These 625 cubic meters of compressed air will carry into the tunnel 5000 cubic meters of air of the normal pressure, so that the ten trains of the night will conduct in 50,000 c. m., or a volume 8,333 times greater than that deteriorated by the passengers on the route.*

The day trains, less heavy but more rapid, will conduct in about the same amount of air.

The pure air thus derived in twenty-four hours, will be in the ratio of 1·15 cubic meters per second, or 45 cubic meters per person. Halls of assembly are known to be exceedingly well ventilated when 10 cubic meters of pure air are received per man per hour. But the air of the tunnel, although it may be considered as confined air, will supply 10·056 cubic meters of air to each man—supposing there be 2200 passengers per day and the time of transit 70 minutes.

While then steam would soon affect respiration, there will be no ill effect in case of the use of compressed air for locomotion. No machine of this kind now exists, it is true, although its possibility has been demonstrated. But when really required, they will soon be supplied. The occasion will present itself when the tunnel of Mount Cenis shall have been constructed: its length is more than twelve kilometers, and only compressed air can be used.

The means of compressing large quantities of air for locomotion are I believe very simple. In the case of the submarine tunnel there are the fires and power rendered useless by the suppression of the steam locomotive; and besides, the winds may be used at the Pas de Calais and on the bank of Varne.

Compressed air is already in use at Mount Cenis, where it is obtained by means of water-falls, which are abundant in the Alps. The machine gives in twenty-four hours 296 cubic meters of air at eight atmospheres. The fall of water which moves it has a force of four horse power. In a communication in 1853† I described some trials by Mr. Julienne with a machine which is a steam engine of eight horse power; it furnishes in 1800 seconds, 8000 litres of air at eight atmospheres of pressure. The amount, which is less than that from the fall of water, corresponds as is seen to forty-eight cubic meters at eight atmospheres in twenty-four hours. But with a power like the wind, we can without too great cost multiply compressing machines and obtain by means of compressed air a moving power as economical as steam.

* I calculate only for adults in good health, and admit with Dumas that such a man burns 300 grams of carbon per twenty-four hours (counting as carbon the hydrogen which is consumed); 300 grams of burnt carbon correspond to 550 litres of carbonic acid. During the 70 minutes which a train will occupy in passing the tunnel, one man will consume then 14·5 grams of carbon and produce 26¼ litres of carbonic acid; and a train of 220 passengers, 5,830 litres; or ten trains with 2200 passengers in all, 58,300 litres, or six cubic meters. In these calculations I take the most unfavorable case; for 300 grams of carbon is a maximum and not a mean. It is not necessary therefore to take into consideration the very interesting facts brought out by Mr. Smith (Phil. Mag., xiv, 547), and which establish, besides other things, the influence of different modes of locomotion on the quantity of carbonic acid given off in the act of respiration.—J. S.

† This Journal, xvi, 278.

Art. XVI.—*The late Dr. Robert Hare.*

During the progress of the forty years of our editorial labors, sorrow has often been awakened as we have been called to record the departure from life of friends and fellow laborers in the common cause.

Robert Hare, the distinguished chemist and philosopher, who died in Philadelphia on the 15th of last May in the 78th year of his age, is entitled to a grateful commemoration in this Journal, to whose pages his contributions were for many years more numerous than those of any other correspondent. The enumeration of the titles merely of about one hundred and fifty articles furnished by him, occupies five columns of the general index of the first fifty volumes of the Journal. He appears in forty-one of those volumes and in seven volumes of the Second Series.

For more than half a century his name has been familiar to men of science as a chemical philosopher, and to the cultivators of the useful arts throughout the civilized world.

Dr. Robert Hare was born in Philadelphia, Jan. 17, 1781. His father was an Englishman, a man of strong mind, and honored in his adopted country by the public confidence. His mother was from a distinguished Philadelphia family. In early life he managed the business of an extensive brewery which his father had established, but his strong leaning toward physical science very early manifested itself and soon led him to abandon the pursuits of a manufacturer and devote his talents and fortune to science. Before the age of twenty he gave evidence of this predilection for scientific pursuits by following the courses of lectures on chemistry and physical science in his native city and by uniting himself with the Chemical Society of Philadelphia, then embracing the names of Priestley, Sybert and Woodhouse.

In 1801 he communicated to this Society a description of the oxyhydrogen blowpipe which he then called a '*hydrostatic blowpipe.*' Prof. Silliman, having been much engaged with him in a series of experiments with this instrument in 1802–3, subsequently distinguished it as the 'compound blowpipe,' having, in fact, on his return from Philadelphia in 1803, constructed for the laboratory of Yale College the first pneumatic trough combining Dr. Hare's invention; an apparatus subsequently figured and described by Dr. Hare in his memoir "on the fusion of strontia and volatilization of platinum."* His memoir to the Chemical Society was separately published in 1801 and was republished in Tilloch's Phil. Mag., London, 1802, and also in the Annales de Chimie (1st series), v, 45.

* Trans. Am. Phil. Soc., vol. vi, p. 99, and plate 3 (June 17, 1803).

This apparatus was the earliest and perhaps the most remarkable of his original contributions to science. It was certainly evidence of a highly philosophical mind, that Dr. Hare, in that comparatively early period in modern chemistry, and when the received notions of the true nature of combustion were so vague, not to say erroneous, should have had the acumen to conceive that a stream of oxygen and hydrogen burning together should produce so intense a heat. Lavoisier, certainly one of the most acute of chemical philosophers and unsurpassed in his skill as an experimentalist, had beaten up the same path so far as to direct a jet of oxygen upon charcoal, and he thus produced a degree of heat by which he fused alumina and other bodies before deemed infusible. He had even brought the elements of water into the same vessel and had there burned them from separate jets, in his famous apparatus for the recomposition of water. But it seems never to have occurred to him that here was a source of heat greater than any then known. In our view Dr. Hare's merit as a scientific philosopher is more clearly established upon this discovery than upon any other of the numerous contributions he has made to science. His original experiments were repeated in 1802–3 in presence of Dr. Priestly, the discoverer of oxygen, then on a visit to Philadelphia, and of Silliman, Woodhouse and others. They were subsequently greatly extended by Prof. Silliman, who, with the apparatus already alluded to, subjected a great number of refractory bodies to the action of the oxyhydrogen jet and published an account of his results in the Memoirs of the Conn. Acad., May 7, 1812.

The discovery of the oxyhydrogen blowpipe was crowned by the Amer. Acad. at Boston by the Rumford medal.

The historian of science will, in view of the facts here quoted, find it needless to notice the disingenuous effort of Dr. Clark of Cambridge, Eng., in his '*gas blowpipe*,' to overlook or appropriate the discovery of Dr. Hare and the researches of Silliman and others, several years after (in 1819) this discovery had been fully before the scientific world,—an effect which must ever remain as a sad stain upon the reputation of this otherwise distinguished man.*

It is not our purpose here to rehearse the history of Dr. Hare's discovery in full, much less to describe all the modifications which the apparatus has received at the hands of its original

* The reader will peruse with interest, in this connection, Dr. Hare's elaborate defence of his own claims and those of his associate, Prof. Silliman, against Dr. Clark's appropriation, in this Journal, [1], vol. ii, pp. 281–302, 1820. Dr. Clark, after a full and spirited protest had been communicated to him, stating fully Dr. Hare's claims and the wrong done him, failed to make any acknowledgment of his error, thus exonerating us from the force of the old maxim, '*Nil de mortuis nisi bonum.*' Dr. Hare heads his strictures on Dr. Clark's book with the well-known lines of Virgil, '*Hos ego versiculos feci, tulit alter honores*,' &c.

discoverer and others. It is well known that in later years he constructed the apparatus on a gigantic scale, with large vessels of wrought iron capable of sustaining the pressure of the Fairmount water works, and that with this powerful combination he was able to fuse at one operation nearly two pounds of platinum.* In these experiments the metal is held upon a refractory fire brick and both are heated as highly as possible in a wind furnace before submitting it to the gas-jet. The product of this fusion from the crude grains is found to be greatly purified, a result probably due to the volatilization at this intense heat of some of the associate metals.

The employment of Dr. Hare's jet to illuminate light houses and signal reflectors under the names of Drummond light and Calcium light is only another example of the mode of ignoring the name of the real discoverer, of which the history of science presents so many parallels.

The fertility of Dr. Hare's inventive mind is illustrated by the numerous and ingenious forms of apparatus which he contrived for research or illustration. To many of these he was led by the necessity of preparing the illustrations for his lectures upon a scale of magnitude adequate to the instruction of the large classes of the Medical School of the University of Pennsylvania. He was called to fill the Chair of Chemistry in that institution in 1818, and continued in the discharge of its duties for nearly a third of a century, and until his resignation in 1847.

He was fond of graphic illustrations; they abound in his memoirs and in his Compendium and other works, and aided by his lucid descriptions his inventions thus become quite intelligible. Where most instructors are satisfied with less perfect and more simple means and explanations, he seemed to be content with nothing short of perfection.

During his long course of research and experimenting, he accumulated a vast store of instruments and materials. An inspection of his repositories and the treasures there accumulated filled the observer with astonishment, and in his lecture room there was always a profusion of apparatus, often instruments of great dimensions, corresponding well with his large mind, with his great physical and intellectual power and unquenchable ardor. He was himself an able and skillful mechanic, and often worked adroitly at the turning lathe and with the other resources of a well furnished shop. In his operations he spared neither labor nor expense, and bestowed both munificently for the accomplishment of his objects.

He devoted great labor and skill to the construction of new and improved forms of the voltaic pile, and it is easy to show

* Roberts in New York has lately with Dr. Hare's apparatus succeeding in fusing perfectly 53 oz. of platinum at one operation.—*N. Y. Tribune, May* 19.

that owing to his zeal and skill in this department of chemical physics, American chemists were enabled to employ with distinguished success the intense powers of extended series of voltaic couples long in advance of the general use of similar combinations in Europe. In place of the cumbrous and unmanageable Cruickshank troughs with which Davy discovered the metallic bases of the alkalies, Dr. Hare introduced his *Deflagrator*, in which any series, however extended, could be instantaneously brought into action or rendered passive at pleasure. The peculiarities of Dr. Hare's deflagrators are too familiar to need any description here. Although the discovery of the constant battery by Daniell, and of the double combinations of platinum or carbon with amalgamated zinc and nitric acid have rendered the old forms of this instrument no longer so useful as formerly, it is not less a proof of the merit of Dr. Hare's apparatus that Prof. Faraday in 1835, after having exhausted his ingenuity and experience in perfecting the voltaic battery, found that Dr. Hare had already, nearly twenty-five years before, accomplished all that he had attempted, and with a noble frankness worthy of all praise, he at once adopted Dr. Hare's instrument as embodying the best results then possible.*

It was with one of Hare's deflagrators that Silliman in 1823 first demonstrated the volatilization and fusion of carbon, a result considered so extraordinary at the time that it was long received with incredulity. Since the general introduction of Bunsen's battery these effects are no longer doubted; all Prof. Silliman's results having been confirmed and extended by Despretz, De La Rive and others.

The deflagrator was invented in 1820.† Four years earlier Dr. Hare had contrived another instrument which he called *the Calorimotor*. In this instrument great extent of surface was obtained from the combining of many large plates (18″ or 24″ square) of zinc and copper into two series and plunging the whole at one movement into a tank of dilute acid. The magnetic and heating effects of this instrument were surprising, and to this day no other form of voltaic apparatus appears to occasion the movement of so great a *volume* of heat with so low a projectile or intensitive force. By it, large rods of iron or platinum, when clamped between its jaws, are first fully ignited and then fused with splendid phenomena, while at the same time its intensity is so low that hardly the least visible spark can be made to pass by it through poles of carbon.

The magnetic effects attributed by Dr. Hare to his Calorimotor have since been shown by Prof. Henry to be attainable, as is now well known, from a single cell if combined with suitable conductors.

* Faraday's Experimental Researches, 1124, 1132.

† This Journal, [1], vol. iii, p, 105.

In the philosophy of chemistry, Dr. Hare has distinguished himself for the zeal and logical acumen with which he combatted what he conceived to be the errors of the salt radical theory. He was ready at all times to engage in controversy upon any point of theory where he conceived there was an error latent. No one can review the numerous letters which he has addressed to the Senior Editor of this Journal, to Berzelius, to Liebig and to Faraday, and published in this Journal, without perceiving that he was no ordinary antagonist.

His theory of whirlwinds and storms was founded on an electrical hypothesis, and he never admitted the rotary theory of the late William C. Redfield. Their discussions were published chiefly in this journal, and will be perused with interest and instruction both on account of the peculiar theories and of the very important series of facts which the controversy has elicited; their personal friends especially will value them the more, as the combatants, both sincere lovers of truth, have now finished their mortal career.

Mr. Redfield declined any oral controversy with Dr. Hare at the meetings of the American Association; but those who were present at the second meeting in New Haven will remember the zeal and energy with which Dr. Hare, in an off-hand speech, fluent and animated, assailed the views of Mr. Redfield, who was all the while a quiet and silent listener. The responses of the latter were always made by the pen and never on public occasions by the tongue.

In his family and among his friends Dr. Hare was very kind, and his feelings were generous, amiable and genial, although occasionally, his manner was abrupt—from absence of mind occasioned by his habitual abstraction and absorption in thought; his mind was ever active, and conversation would sometimes seem to awaken him from an intellectual reverie. He had high colloquial powers, but to give them full effect, it was necessary that they should be roused by a great and interesting subject, and especially if it assumed an antagonistic form. He would then discourse with commanding ability, and his hearers were generally as willing to listen as he was to speak.

He was a man of unbending rectitude, and a faithful friend both in prosperity and adversity.

His frame was robust—powerful and ample in structure, and of strong muscular development, having been invigorated in earlier years by skillful training; and had there been occasion, he would have made a formidable physical antagonist. His head was large and of noble model; no stranger could meet him without being impressed by a figure of such grandeur and a head and features so remarkable.

Dr. Hare was an ardent patriot, who loved his country and cherished its institutions not for office or emolument, which he

never sought or received, but from pure and lofty motives. He was of the school of Washington—an enthusiastic admirer of that great man—a federalist, while that primeval party had a name and retained vitality—and when it passed by an imperceptible transition into another form, he was found among the whigs. He occasionally wrote upon the great political and financial questions which agitate the public mind. These discussions like all his writings, were always marked by vigorous thought, large views, and elevated patriotism.

He was not however so exclusively a man of science as to ignore the charms of literature. His particular friends know that his philosophy was sometimes softened by listening to the muses, and he occasionally indulged in poetical composition.

Dr. Hare was one of the few life members of the Smithsonian Institution to which he gave soon after he resigned his profesship, all his chemical and physical apparatus, which has thus become the property of the nation.

SCIENTIFIC INTELLIGENCE.

I. CHEMISTRY AND PHYSICS.

1. *On the crystallographical and chemical relations of Hornblende and Augite.*—RAMMELSBERG has published an elaborate investigation of this interesting and often mooted subject, and has arrived at the following results which we give in the author's own words, referring to the original paper for the very numerous analyses and formulas by which they are supported.

(1.) A series of isomorphous silicates, whose principal members are augite and hornblende, forms a larger group, that of the augites. Their structure separates them into two groups, at the head of each of which one of the two minerals stands as a type. A member of the first division by fusion passes into one of the second. Wollastonite, acmite, aegirin, babingtonite, silicate of manganese, hypersthene, diallage and spodumene, belong to the augite-type; anthophyllite and arfvedsonite, to the hornblende-type. The forms of all these minerals may be referred to each other.

(2.) The chemical character of the group is that the members are bisilicates.

(3.) The members may be classified according to the chemical character of their constituents into four divisions, which are characterized by the presence or absence of sesquioxyds.

A. Pure bisilicates of monoxyds. Wollastonite, diopside, the light colored augites generally, but also black ones rich in protoxyd of iron, hypersthene, and for the most part bronzite, rhodonite and fowlerite belong to the augite type; the light colored hornblendes, at least tremolite and actinolite, as well as anthophyllite, to the hornblende type.

B. Those which contain sesquioxyd of iron but no alumina. Acmite, aegirine and babingtonite belong to the augite type, arfvedsonite to the hornblende type.

C. Those which contain sesquioxyd of iron and alumina. These are the aluminous augites and hornblendes.

D. Those which contain alumina but no sesquioxyd of iron. Spodumene of the augite type is the only member.

(4.) The assumption of a larger quantity of oxygen in the hornblendes or of the existence of a bisilicate in them rests only in the imperfections of former analyses. The aluminous augites and hornblendes contain protoxyd and sesquioxyd of iron, the latter in addition a considerable quantity of alkalies.

(5.) Sesquioxyd of iron is everywhere present as a base and its bisilicate is isomorphous with the bisilicate of protoxyd of iron and other monoxyds.

(6.) The aluminous augites and hornblendes have an analogous constitution, which is at the same time that of all the other members, only in case the alumina is an electro-negative constituent.—*Pogg. Ann.*, ciii, 273, 435.

2. *Researches on the double nitrosulphids of iron.*—Roussin has discovered a new series of compounds containing deutoxyd of nitrogen and sulphid of iron and exhibiting in some respects a remarkable analogy to the nitroprussids of Playfair. When a solution of a per-salt of iron is added drop by drop to a mixture of solutions of an alkaline nitrite and an alkaline sulphydrate and the liquid is kept constantly agitated, a voluminous black precipitate is thrown down which on boiling dissolves almost completely. The filtered liquid deposits black crystals which are oblique rhombic prisms. They are soluble in boiling water, alcohol, woodspirit and ether. Five centigrams communicate to one litre of water the color of brandy. Their taste is styptic and afterwards bitter. The solution gives precipitates of sulphids, in many metallic solutions NO_2 being given off. The author represents the constitution of this body by the formula $Fe_2S_3, NO_2 + FeS.NO_2 + HS$, and adopts for it the name of *binitrosulphid of iron.* When the binitrosulphid of iron is boiled with a solution of caustic soda, ammonia is given off in abundance and a crystallized sesquioxyd of iron deposited. The filtered liquid deposits large black crystals which appear to have the formula $Fe_2S_3.NO_2\,3NaS$; the author calls this substance *sulphuretted nitrosulphid of iron and sodium.* Dilute sulphuric acid added to a boiling solution of this salt precipitates a heavy black substance which has the formula $Fe_2S_3.NO_2$, and which the author calls nitrosulphid of iron. By dissolving this body in sulphid of sodium a new salt is obtained having the formula Fe_2S_3, NO_2, NaS, HO. This salt gives precipitates with many metallic solutions in which the metal replaces sodium. In all these compounds the iron is not indicated by ordinary tests, and the author points out their analogy to the double cyanids and especially to the nitroprussids, which last also contain deutoxyd of nitrogen.—*Ann. de Chimie et de Physique*, 411, 285, *March*, 1858.

3. *Chemical theory of gunpowder.*—Bunsen and Schischkoff have published a memoir upon this subject which not merely furnishes the

first complete solution of the problems involved in the theory of the explosion of gunpowder, but which is particularly rich in new methods of investigation and analysis. The authors from want of time were obliged to confine their researches to one kind of powder and to its combustion under the ordinary atmospheric pressure. The methods employed however will apply with slight modifications to other cases. The powder gave on analysis

Saltpeter,		78·99
Sulphur,		9·84
Carbon,	Carbon,	7·69
	Hydrogen,	0·41
	Oxygen,	3·07
	Ash,	*trace.*
		100·00

A preliminary qualitative analysis gave the following substances as solid products of the combustion of the powder employed: 1. sulphate of potash, 2. carbonate of potash, 3. hyposulphite of potash, 4. sulphid of potassium, 5. hydrate of potash, 6. sulphocyanid of potassium, 7. nitrate of potash, 8. carbon, 9. sulphur, 10. carbonate of ammonia. The gaseous products were, 1. nitrogen, 2. carbonic acid, 3. carbonic oxyd, 4. hydrogen, 5. sulphid of hydrogen, and occasionally 6. nitric and nitrous oxyds. By means of a particular apparatus the authors were able to prepare the solid residue of the explosion, the smoke or vapor which accompanies it, and the gaseous products and to analyze each separately. For the elaborate details of the analyses we must refer to the original memoir. The solid residue was found to contain

Sulphate of potash,	56·62
Carbonate of potash,	27·02
Hyposulphite of potash,	7·57
Sulphid of potassium,	1·06
Hydrate of potash,	1·26
Sulphocyanid of potassium,	0·86
Saltpeter,	5·19
Carbon,	0·97
Sulphur,	*trace.*
	100·52

The condensed smoke or powder-vapor was found to contain

Sulphate of potash,	65·29
Carbonate of potash,	23·48
Hyposulphite of potash,	4·90
Hydrate of potash,	1·33
Sulphocyanid of potassium,	0·55
Nitrate of potash,	2·48
Carbon,	1·86
‡ Carbonate of ammonia,	0·11
	100·00

These analyses show clearly that the residues of the explosion of gunpowder consist essentially of sulphate and carbonate of potash and not of sulphid of potassium as is erroneously assumed in military books. The gaseous products of the explosion were found to be

Carbonic acid,	52·67
Nitrogen,	41·12
Carbonic oxyd,	3·88
Hydrogen,	1·21
Sulphid of hydrogen,	0·60
Oxygen,	0·52
	100·00

From this analysis it also appears that the old theory of the explosion is incorrect, since according to it nitrogen and carbonic acid should be present in the ratio of 1 : 3, whereas the actual ratio is not even as 1 : 1·5. The authors found further that 1 gram of the powder used by them gave 0·6806 gr. of solid residue and 193·1 c. c. of gas or one-third less than should be given according to the old theory. To determine theoretically the work done by the explosion, the authors first determined the quantity of heat evolved in the combustion, which was found to be in heat units 643·9 C. for 1 gram of powder. This number requires however to be corrected for the heat evolved by the combustion of the gaseous products in the combustion tube filled with air, amounting to 24·4 units, so that the true heat of combustion is 619·5 C. The calculated quantity of heat, supposing that the combustible ingredients of the powder burn freely in oxygen, is 1039·1 C.: the difference is easily explained by the absorption of heat on the part of the nitrogen set free. The temperature of the flame of the powder is found by dividing the number 619·5 by the specific heat of the products of the explosion, namely 0·207, and is therefore equal to 2993° C. When however powder burns in a space in which it cannot expand, the number 619·5 must be divided by the specific heat of the products of the combustion under a constant volume, which is 0·18547, and the temperature of the flame is therefore 3340° C. These values, 2993° C. and 3340° C., are approximations which cannot be far from the truth. The authors in the next place show that the received theory that the solid residue of the explosion of the powder exert a sensible tension is wholly unfounded since this residue does not boil at the temperature of hydrogen burning in air, which is 3259° C., and its tension even at that temperature cannot therefore equal a single atmosphere. The authors next calculate the pressure in atmospheres which the powder exerts at the moment of explosion and find it 4373·6, of which about 1000 are due to the expansion of the solid residue. The pressure which the powder employed could exert upon the sides of a cannon would, as these results show, never exceed 4½ thousand atmospheres. Hence it appears that the statements of the best authorities on artillery that this pressure amounts to 50,000 or 100,000 atmospheres are entirely without foundation in fact. One kilogram of the powder employed could exert in its explosion a theoretical work of 67410 meterkilograms.—*Pogg. Ann.*, cii, 321. W. G.

4. *Test for Cinchonia;* by J. W. Bill, Acting Surgeon, U. S. A., (communicated for this Journal).—In some investigations still in progress on some of the alkaloids it became a matter of importance to discover a good test for cinchonia delicate and characteristic and distinguishing it especially from quinia.

We think we have found such a test, and as we believe it to be a reaction not before noticed, at least not applied to the above purpose, we will

anticipate the results of the above-mentioned investigations and give the test by itself.

When ferrocyanid of potassium is added to a salt of quinia in the cold, a yellowish white cloudy precipitate falls, provided the ferrocyanid be not added in excess; otherwise nothing characteristic results. This precipitate is soluble by heat and readily so in solutions of ferrocyanid of potassium without any subsequent change occurring in the solution. If ferrocyanid of potassium be added to a soluble salt of cinchonia, whether added in excess or not, whether added to a strong or a weak solution, a yellow white curdy precipitate falls. If a very gentle heat be now applied this precipitate dissolves, but as the liquid cools again a crop of splendid yellow (gold-yellow) crystals falls so abundantly as sometimes to give a gelatinous appearance to their mass. These crystals are flat plates, cuneiform in shape, a pure lemon-yellow in color, and superimposed one upon the other in the same way as are crystals of nitrate of urea. The crystals are best observed under a low magnifying power, fifty diameters, and will then be found such as we have described them. The *precipitate* is not soluble in excess of ferrocyanid of potassium, but like this latter is decomposed by boiling with mineral acids. This test for cinchonia is a very delicate one, not less so than that by the biniodid of potassium, and is far more characteristic, since none of the alkaloids manifest the reaction except cinchonia. In practice it will be well, for obvious reasons, to use a slight excess of ferrocyanid of potassium, as little excess of acid as possible, and to heat the liquid *very* gently after the first precipitate has fallen.

5. *Note on the use of the Molybdate of Ammonia test for Phosphoric Acid;* by J. W. Bill, Acting Surgeon, U. S. A., (communicated for this Journal).—We observed on one occasion that on conducting the process for the detection of phosphoric acid in a liquid we were nearly sure contained it, that we obtained a green, a splendid chrome-green, instead of the characteristic yellow precipitate. This was observed in the laboratory of Mr. Henry Wurtz, who examined the liquid and corroborated an examination we had made proving that a soluble iodid was present as well as phosphoric acid. For a while we were puzzled to account for this phenomenon, but it appears to us that it may be explained thus.

The free nitric acid liberated some iodine and this reduced the molybdate to the state of the molybdo-molybdate, Mb_2O_5, and this in solution is a cobalt-blue. This blue liquid on being mixed with the yellow precipitate gave the green color observed. Iodid of potassium and nitric acid when added to the yellow precipitate decompose it, forming the same green colored liquid. If this is sealed up in a glass tube, in about three weeks large crystals of iodine will be found lining the sides of the tube, the liquid will have become brown-red in color and a gas will have been eliminated sufficient sometimes to have burst the tube. The reaction may be expressed in a formula thus: the yellow precipitate, the nitric acid, the iodid of potassium will give $2[NH_4O, MbO_3]+2[NO_5]+KI+PO_5=Mb_2O_5$ (molybdate of molybdenum) $+2(NH_4ONO_5)+KOPO_5+I$.

6. *On some reactions of the salts of lime and magnesia;* by T. Sterry Hunt, (Extract of a letter to J. D. Dana, dated Quebec, May 29, 1858).—In a recent paper on the earthy carbonates (*Ann. de Chimie et de Physique*, third series, vol. li, p. 302), Bineau concludes that the car-

bonates of magnesia react with the soluble salts of lime like the corresponding carbonates of the alkalies. This is so far true that a solution of bicarbonate of magnesia precipitates carbonate of lime from a solution of chlorid of calcium, while the basic carbonate of magnesia separates the carbonate of lime from its solution in carbonic acid. It results from this that when bicarbonate of soda is added to mixed and somewhat dilute solutions of chlorids of calcium and magnesium, the whole of the lime is precipitated as a nearly pure carbonate, while the magnesia remains dissolved either as chlorid, or as bicarbonate, which is much more soluble than that stated by Bischof, since according to the determinations of Bineau and my own, water may dissolve as bicarbonate more than one per cent of MgO.

I have found that when we evaporate, at from 60° to 100° F., a solution of bicarbonate of lime with an excess of sulphate of magnesia, the whole of the lime is separated in the form of gypsum, and there remains bicarbonate of magnesia in solution. The same thing happens in presence of sea-salt and chlorid of magnesium provided sulphates are present. These solutions of bicarbonate of magnesia give rise to deposits of carbonate of magnesia by further evaporation. Deville has observed that the slow action in the presence of water, between carbonate of magnesia and bicarbonate of soda, aided by a gentle heat, results in the production of a crystalline anhydrous double carbonate of magnesia and soda, analogous to dolomite, and I am led from some yet unfinished experiments to suppose that a similar reaction between the carbonates of lime and magnesia in the presence of carbonic acid may yield the double carbonate of lime and magnesia, and thus explain the formation of magnesian limestone.

7. *Boron.*—Prof. Q. Sella of Turin has published an elaborate memoir on the crystals of the so-called *adamantine* condition of boron, illustrated by many fine figures, in the Memoirs of the Turin Academy, [2], vol. xvii. The form of part of the crystals, as before described by Sella, is dimetric, and either modified octahedrons or prisms. The axis $a = 0{\cdot}576$. The forms observed are 1, *I*, 2, 2-2, 1-*i*, *i*-*i*; the face of composition 1-*i*. Wöhler and Deville mention three varieties of the adamantine boron, and these crystallographic determinations relate to the last two, neither of which is pure, one containing B 89·1, Al 6·7, C 4·2=100, and the other also holding much aluminium and carbon. The first variety consists of boron 97·6, carbon 2·4=100; and this nearly pure boron Sella finds to occur under a different form, which may be monometric (or monoclinic approaching closely to monometric); and the *Graphitoid* boron is probably the same in a fine state. The point is discussed at considerable length in the memoir.

II. GEOLOGY AND MINERALOGY.

1. *On the Order in the Coal Measures of Kentucky and Illinois and their relations to those of the Appalachian Coal-field;* by Mr. Leo Lesquereux.—In our last number we alluded to the Report by Mr. Lesquereux on the Coal Measures of the United States in the third volume of the Kentucky Geological Report. The following is the succession of the coal beds in Kentucky, (beginning with the lowest,) and some of their parallelisms with more eastern coal regions, as made out by him.

1st. Cook's coal; Bell's coal bed; Breckinridge cannel; Hawesville coal. Appears in some places to be in two beds, 1A, 1B.—1B is Lesley's B, the *mammoth coal bed* of the anthracite region (Wilkesbarre, Carbondale, Tamaqua, Lehigh, &c.), and also the best vein in Kentucky; Kenawha salines; Cuyahoga Falls, Ohio. 1A (Lesley's A) is a thin bed, the first above the conglomerates, 2 feet thick at Nelsonville, Ohio, 1½ ft. on the Great Kenawha, 1 to 2 feet on the Alleghany in Pennsylvania.

2d. "Thin Coal,"—probably Lesley's C, cannel coal of Kittanning, Peytona, Darlington.

3d. "Ice House Coal,"—probably Lesley's D, Lower Freeport, Beaver River, Cook vein (?) on Broad Top; Zanesville, Ohio.

4th. "Curlew" Coal, in Curlew Hill.—The Pomeroy coal of Ohio; Gates and Salem veins, highest of anthracite, near Pottsville, Pa., affording some fossil plants.

Next follows in order the MAHONING SANDSTONE, an important horizon.

5th. A four foot bed.—Ferns have some resemblance to those in the roof of anthracite bed, in Shamokin valley, Pa.

6th. "Little vein," Mulford's mines, Union Co., Ky.—Steiger's bed, at Athens, Ohio.

7th. "Thin Coal," seen at Saline Coal Co. property, in Illinois.

8th. Well Coal.—The *great Pittsburg* bed, 14 feet thick in the Cumberland basin; 11 ft. in Elk Lick, Somerset Co.; 9 ft. in Ligonier valley and Pittsburg; 6 ft. at Wheeling; 5 ft. at Athens, O.; or a diminution of 9 feet in 180 miles.

9th. A reliable bed in western Kentucky: at Curlew Mines; "Five foot Mulford Coal," etc.

10th. "Middle Coal."

11th and 12th. Coal under *Anvil Rock*. No. 11 (2—9 feet thick) corresponds probably to the first in limestone over the Pittsburg seam in Pa., and 12 to the next. Above the Anvil Rock, (13 and 14,) appear to correspond to others still higher in Lesley's section. Mr. Lesquereux observes that from No. 8, or the Pittsburg seam, to No. 14, is 400 feet in western Pennsylvania, and 395 in Kentucky.

The Anvil rock of Kentucky Lesley regards as on the same horizon with the conglomerate of the 12th Shamoken coal bed.*

The distinguishing fossils of these coal beds are as follows.

1st Bed. Large Trees; *Sigillaria, Calamites, Lepidodendron;* the fruits of *Lepidodendron, Lepidostrobus, Lepidophyllum*, abundant; *Stigmaria; Sphenopteris*, here and seldom seen above. Among the species, there are *Pecopteris lonchitica* only here; *Alethopteris Serlii, Neuropteris Clarksonii* and *N. hirsuta*, of which the last runs through the whole Coal Measures: *Sphenopteris intermedia, Asterophyllites ovalis, Calamites Suckovii, Lepidodendron politum, Lepidophloios rugosus, Lycopodites Sticlerianus*, etc.; *Carpolithes, Cardiocarpon, Trigonocarpon. Lingula umbonata* in the black shales in Kentucky, Ohio, Virginia, Pennsylvania.

2d. *Lingula umbonata*, etc.

3d. *Neuropteris hirsuta, N. flexuosa*, the latter also running through the Coal Measures.

* See an important paper by J. P. Lesley, on these parallelisms, Proceedings Amer. Assoc. xi, 39.

4th. *Neuropteris flexuosa, Pinnularia, Asterophyllites, Sphenophyllum* and *Annularia, Neuropteris fimbriata*, &c., *Pecopteris arborescens*, Brt., *Flabellaria boracifolia*, Sternb.; some *Calamites, Sigillaria, Stigmaria*, but no *Lepidodendron* or *Lepidostrobus* seen.

5th. *Neuropteris tenuifolia*, Br., very near *N. flexuosa*.

8th. *Pecopteris heterophylla*. Most of the species not well defined.

9th. *Avicula rectilateraria, Productus muricatus*. *Fish* remains. *Calamites, Sigillariæ*.

11th. *Pleurotomaria* of various species, *Productus Rogersii? Nucula Hameri? Avicula* near *A. rectilateraria*. *Sigillaria* seems to be wanting. Fish remains like those of No. 9.

12th. *Stigmaria, Calamites;* some scarce *Sigillariæ*.

2. *The Fossil Plants of the Coal Measures of the United States, with descriptions of the New Species in the Cabinet of the Pottsville Scientific Association;* by Leo Lesquereux. 24 pp., 8vo, with two plates. Read before the Pottsville Sci. Association, Feb. 13, 1858. Pottsville, Pa.—In this paper Mr. Lesquereux has enumerated all the known species of North American coal plants, besides describing some that are new. In all, about 300 species are mentioned; but Mr. Lesquereux remarks that already 50 new species have been collected and are not included in his catalogue; and the number when fully known will probably be near 400.

Mr. Lesquereux calls the Gates and Salem veins near Pottsville and the Pomeroy coal of Ohio, together with the beds above them (see preceding page) as the Upper Coal Measures, and the beds below, the *lower*. The lower are the *white-ash* coal, and the upper the *gray-ash* and *red-ash* of Pennsylvania. The synchronism of the Gates and Salem veins with the Pomeroy is shown by the identity of many of the fossil plants, while several of the species occur nowhere else. The following is a brief abstract of the Catalogue.

A. *Neuropterideæ*.—Fronds pinnate or bipinnate. Secondary veins either rising from a medial nerve vanishing above, or emerging and branching from the base of the leaflets without a medial nerve.

1. Noeggerathia, 6 species, all from the "Old Red Sandstone."
2. Odontopteris, 7 species, mostly from the *Lower* coal.
3. Dictyopteris, 1 species, from *Upper* coal.
4. Cyclopteris, *C. flabellata*, Brongn., *Whittleseya elegans*, Newberry, *Lower* coal.
5. Nephropteris, 8 species. Mostly from *Upper* coal. "The genus can scarcely be separated from the following, most of its species being only large deciduous leaflets attached around the main rachis of *Neuropteris*."
6. Neuropteris, 27 species, mostly from the middle and upper coal.

B. *Sphenopterideæ*.—Frond bi-tripinnatifid or bi-tripinnate; pinnules mostly lobed, sometimes entire; nerves pinnately forking, with a primary nerve slightly distinct, flexuous; secondary nerves obliquely ascending in each division, either simple or forking near the apex.

1. Sphenopteris, 27 species. The genus includes two groups, one having round large entire leaflets belonging to the *lower* coal, the other to the *upper*.
2. Hymenophyllites, 8 species. Six would be added to Schizopteris by some authors, and these are mostly or wholly from the *upper* coal; the others are from the *lower*.

C. *Pecopterideæ*.—Frond simple? pinnate, bi-tripinnate or bi-tripinnatifid; pinnules attached to the rachis by the whole base, sometimes

united together. Medial nerve well marked; secondary nerves emerging more or less obliquely from the medial nerve, simple or furcate.

1. ASPLENITES, 1 species, upper coal.
2. ALETHOPTERIS, 15 species. Appear to be distributed through upper and lower coal.
3. CALLIPTERIS, 1 species.
4. PECOPTERIS, 25 species. Characterize mostly the upper coal, several species in the lower.

D. Of Doubtful Family.

CREMATOPTERIS, 1 species. SCOLOPENDRITES, 1 species. SCHIZOPTERIS, 1 species, lower coal. CANNOPHYLLITES, 1 species. CORDAITES, 1 species, upper coal.

E. *Asterophylliteæ.*—Includes herbaceous plants or trees, the stems ordinarily striated lengthwise.

1. SPHENOPHYLLUM, 9 species, upper and lower coal.
2. ANNULARIA, 4 species, mostly upper coal.
3. ASTEROPHYLLITES, 9 species, upper coal.
4. CALAMITES, 14 species, upper and lower.

F. Stems of Trees.

1. CAULOPTERIS, 3 species, mostly or wholly lower coal.
2. DIPLOTEGIUM, 1 species, lower coal.
3. STIGMARIA, 7 species, upper and lower coal; the *Stigmaria ficoides* from the base to the top of the Coal Measures.
4. SIGILLARIA, 37 species, mostly lower coal.
5. SYRINGODENDRON, 3 species, upper and lower coal.
6. LEPIDODENDRON, 18 species, lower coal.
7. LEPIDOPHLOIOS, 2 species, lower coal.
8. ULODENDRON, 2 species, lower coal.
9. MEGAPHYLLUM, 1 species, lower coal.
10. KNORRIA, 3 species, lower coal.

G. Cones, Fruits.

Lepidophyllum, 7 species, lower coal. *Lepidostrobus*, 4 species, lower coal. *Brachyphyllum* (?) 1 species, lower coal. *Cardiocarpon*, 9 species, lower coal. *Rhabdocarpos*, 3 species. *Trigonocarpon*, 7 species, mostly lower coal. *Carpolithes*, 10 species, lower coal.

3. *On the Coal Measures of Missouri;* by G. C. SWALLOW.—In connection with the above it is interesting to consider the observations made in Missouri by G. C. Swallow and published in his State Geological Report for 1855. He divides the Coal Measures into the Upper, Middle and Lower. The following is an abstract of the sections, commencing above, and mentioning the most common fossils.

I. *Upper Coal Series.*

1. 10 feet of limestone. *Fossils: Fusulina cylindrica, Productus costatus, P. aquicostatus, Orthis Umbraculum.*
2. 3 feet of yellow and blue shale. 3. 3 feet of bituminous shale.
4. 3 feet limestone. *Fossils: Terebratula subtilita, Productus costatus.*
5. 15 feet of bituminous and blue shale.
6. 20 feet of limestone. *Fossils:* same as in No. 1, with also *Spirifer Meuschachanus, S. lineatus, S. plano-convexa, Productus Wabashensis, Chonetes granulifera, Terebratula subtilita.*
7. 12 feet of shale. 8. 7 feet of friable sandstone.
9. 4 feet limestone. *Fossils:* nearly as in No. 6.
10. 20 feet of shale. 11. 5 feet of sandstone.
12. 16 feet of calcareous and bituminous shales. *Fossils: Tereb. subtilita, Orthis Umbraculum, Spirifer Kentuckensis.*
13. Shaly sandstone.

14. 18 feet limestone. *Fus. cylindrica, Tereb. subtilita* (abundant), *Orthis Umbraculum, Sp. Kentuckensis, Productus punctatus, P. costatus.*
15. 17 feet of shale. 16. 3 feet of limestone. 17. 20 feet of shale.
18. 10 feet of limestone. *Fossils: Fus. cylindrica, Prod. costatus, Tereb. subtilita, Campophyllum torquium.*
19–22. 39 feet of shale with some sandstone and limestone.
23. 20 feet limestone. *Fossils:* same as in No. 14, with also, *Spirifer lineatus, S. hemiplicatus, S. Meusebachanus, Productus æquicostatus, P. Nebrascensis, Allorisma terminalis, A. regularis, Bellerophon hiulcus, Chætetes milleporaceus.*
24. 5 feet of shale. 25. Limestone, with *Fusulina cylindrica.*
26, 27. 4 feet of shale.
Thin layers of COAL occur in numbers 7, 15, 24, 27.

II. *Middle Coal Series.*

28. 5 feet of ripple-marked sandstone.
29. 30 feet of shale with mud cracks. 30, 31. 11 feet of shale.
32. ½ foot of COAL.
33. 6 feet of blue clay. *Fossils: Fusulina cylindrica, Terebratula subtilita, Orthis Umbraculum, Chonetes granulifera.*
34. 10 feet of sandstone. 35. 6 feet of shale.
36. 4 feet of limestone, the upper part shaly and full of *Fusulinæ, Chonetes, Producti, Crinoidea;* the lower hard and siliceous with huge lenticular masses of *Chætetes milleporaceus.*
37–40. 33 feet of clay and sandstone with some limestone.
41. 4 feet limestone. Contains *Ch. milleporaceus* and *Fus. cylindrica.*
42. 7 feet limestone. *Fossils: Orthis Umbraculum, Chonetes variolata, C. mesoloba, Terebratula subtilita, Fus. cylindrica.*
43. 4 feet of shale.
44. 5 feet of limestone. *Fossils: Ter. subtilita, Sp. lineatus, Fus. cylindrica.*
45, 46. 2 feet of shale overlying 2 feet of good COAL.
47, 48. 2 feet of shale over 6 feet limestone containing *Fus. cylindrica.*
49, 50. 24 feet shaly sandstone and shale.
51, 52. 5 feet of shale overlying ½ foot of COAL.
53. 6 feet of shale.
54. 4 feet of limestone. *Fossils: Allorisma terminalis, A. regularis, Prod. costatus, Sp. Meusebachanus, Bell. hiulcus.*
55. 1 foot of clay. 56. 6 feet of limestone. 57. 12 feet of shale.
58. Two-thirds of a foot of COAL. 59. 4 feet of shale.

III. *Lower Coal Series.*

60. 75 feet of micaceous sandstone, the lower part abounding in vegetable remains, *Calamites, Sigillaria, Lepidodendron.*
61. 3 feet of sandy shale; not persistent.
62. 1 foot of COAL—sometimes failing. Fossils: in earthy concretions, *Leda arata, Goniatites planorbiformis,* etc.
63. 4 feet of shale.
64. 6 feet of COAL, varying from 3 to 6 feet, and in some places wanting.
65. 1 foot of shale.
66. 8 feet of hydraulic limestone. Fossils: *Chætetes milleporaceus, Chonetes mesoloba, Productus splendens, Spirifer lineatus, S. Meusebachanus, Fusulina cylindrica, Terebratula subtilita.*
67. 6 feet of shale.
68–72. 17 feet, 3 layers of COAL, ½ to 1½ foot thick, alternating with shale.
73, 74. 5 feet of shale overlying 3 feet of COAL.
75. 23 feet of shales and fire clay.

The upper coal series has thus a thickness of about 300 feet, the middle of 200, and the lower of 150, in all 650 feet. But in other parts of the State the thickness is greater. The following fossils do not descend below the Coal Measures:

Fusilina cylindrica,
Spirifer Meusebachanus,
" plano-convexa,
" hemiplicata,
" Kentuckensis,
Productus splendens,
" æquicostatus,
Productus Nebrascensis,
" costatus,
" Wabashensis,
Terebratula subtilita (?)
Chonetes mesoloba,
" parva,
" Smithi,
Myalina subquadrata,
Allorisma regularis,
" terminalis,
Leda arata,
Pleurotomaria spherulata,
Campophyllum torquium,
Chætetes milleporaceus.

The following species are common to the Subcarboniferous Limestone and the Coal Measures: *Productus punctatus, P. Cora, P. muricatus, P. semireticulatus, Spirifer lineatus, Orthis Umbraculum.*

In this connection reference should also be made to the paper by Messrs. Shumard and Swallow, mentioned in our last volume, at page 447.

4. *Permian in Kansas.*—Prof. SWALLOW, in the paper announced in our last number (vol. xxv, p. 442), gives a section of the Permian rocks, taken by Mr. Hawn. According to it, they are 820 feet thick—263 of the whole being separated as the *upper* Permian, and the rest the *lower* Permian. The rocks are limestones with some shales or clay layers, and some of the limestones containing hornstone.*

Above the Permian in Kansas there are 420 feet of sandstone with some calcareous and argillaceous layers, and occasional beds of gypsum. These rocks are referred with a query to the Triassic, but may be Jurassic or Cretaceous. A *trilobate exogenous* leaf is mentioned as the only observed fossil plant, and this would favor the last conclusion. Above these beds, there are in the section 2 feet of Cretaceous rocks, and 169 of "Quarternary."

The Permian is a direct continuation apparently of the Coal Measures without unconformability. The Carboniferous rocks have a thickness in Kansas of 1070 feet, and are supposed to be higher in the series than the Upper Coal Series of Missouri. Between the Permian and the overlying strata there appears to be an entire unconformability.

Of the 75 species of fossils found in the Permian rocks and published by Prof. Swallow, only 16 occur also in the Carboniferous; yet, while the majority of the species are peculiar to the Permian, the majority of the individuals are Carboniferous. The following is a list of the Permian fossils: those that occur also in the Carboniferous are indicated by an asterisk.

Stenopora crassa, *Lonsdale.*
" spinigera, *Lonsdale.*
Chætetes, three species (*undetermined*).
Fenestella flabellata (?) *Phillips.*
Synocladia virgulacea (?) *King.*
Thamniscus dubius, *Schlotheim.*
Acanthocladia anceps (?) *Schlotheim.*
Phyllopora Ehrenbergi, *Geinitz.*
Archæocidaris Verneuiliana, *King.*
Cyathocrinus ramosus (?) *King.*
Serpula (Spirorbis) valvata, *Goldfuss.*
Spirorbis orbiculostoma, *Swallow.*
Phillipsia, *species not determined.*
Productus Calhounianus, *Swallow.*
" semireticulatus,* *Martin.*
" Rogersii,* *Norwood & Pratten.*
" æquicostatus,* *Shumard.*
" Norwoodii, *Swallow.*
Spirifer cameratus,* *Morton.*
" planoconvexa,* *Shumard.*
" pectinifera (?)* *Sowerby.*
Chonetes Flemingii,* *Norwood & Pratten.*
Orthisina umbraculum,* *Buch.*
" Shumardiana, *Swallow.*
" Missouriensis,* *Swallow.*
Rhynchonella Osagensis,* *Swallow.*
Terebratula (?) subtilita,* *Hall.*
Monotis speluncaria (?) *Schlotheim.*
" " var. Americana, *Swallow.*
" radialis, *Phillips.*
" variabilis, *Swallow.*
" Halli, *Swallow.*
Avicula gryphæata (?) *Munster.*
Pecten Cleavelandicus, *Swallow.*
" ringens, *Swallow.*
" acultialatus, *Swallow.*

* A paper on the Kansas Permian by Prof. Swallow has just been received while these pages are in type, and will appear in our next.

Mytilus (Myalina) Permianus, *Swallow.*
" " concavus, *Swallow.*
" " squamosus, *Sowerby.*
" " rectus,* *Shumard.*
Myalina subquadrata,* *Shumard.*
" Kansasensis,* *Shumard.*
Bakevellia antiqua, *Munster.*
" pulchra, *Swallow.*
Edmondia gibbosa, *Swallow.*
" Otoensis, *Swallow.*
" semiorbiculata, *Swallow.*
Nucula (Leda) Kazanensis, *Vern.*
" speciosa (?) *Munster.*
" (*species not determined*).
Solemya biarmica (?) *Verneuil.*
" (*species undetermined*).
Solen (?) Permianus, *Swallow.*
Cardiomorpha rhomboidea, *Swallow.*
" Kansasensis, *Swallow.*
Cardinia cordata, *Swallow.*
" subangulata, *Swallow.*
Cardina (*species undetermined*).
" Listeri (?) *Sowerby.*
Pleurophorus (?) Permianus, *Swallow.*
Schizodus obscurus, *Sowerby.*
" triangularis, *Swallow.*
" Rossicus, *Verneuil.*
Lyriodon (Myophoria) orbiculare, *Goldf.*
Allorisma lanceolata, *Swallow.*
" curta, *Swallow.*
" Minnahaha,* *Swallow.*
Murchisonia subangulata (?) *Vern.*
" Kansasensis, *Swallow.*
" perversa, *Swallow.*
Loxonema fasciata, *King.*
Macrocheilus spiratus, *McCoy.*
Naticopsis Pricei,* *Shumard.*
Nautilus Permianus, *Swallow.*
" occidentalis, *Swallow.*
Orthoceras Kickapooense, *Swallow.*
Cyrtoceras dorsatum, *Swallow.*

The following species, viz., *Spirorbis valvata*, *Monotis speluncaria* var. *Americana*, *M. radialis*, *M. variabilis*, *Avicula gryphæata*, *Myalina Permiana*, *M. concava*, *Bakevellia antiqua*, *Solemya*, *Solen* (?) *Permianus*, *Schizodus Rossicus*, *Murchisonia subangulata* (?), *Nautilus Permianus*, *Orthoceras Kickapooense*, *Cyrtoceras dorsatum*, occur only in the Upper Permian. *Monotis Halli* is alone in occurring in both the upper and lower Permian. These results may be much modified by farther discovery.

Messrs. MEEK and HAYDEN, in their paper on the Permian of Kansas published just before the above-mentioned paper by Prof. Swallow, (see our last volume, p. 442,) describes the following species as new: *Monotis Hawni*, *Myalina* (*Mytilus*) *perattenuata*, *Leda* (*Nucula*) *subscitula*, *Bakevellia parva*, *Edmondia? Calhouni*, *Pleurophorus? occidentalis*, *P.* (*Cardinia*) *subcuneata*, *Lyonsia* (*Panopæa*) *concava*, *Panopæa Cooperi*, *Nautilus eccentricus.*

5. *Descriptions of New Organic Remains collected in Nebraska by Dr. F. V. Hayden*, Geologist to the Exploring Expedition under the command of Lieut. G. K. Warren, Top. Engineer, U. S. A., together with some remarks on the geology of the Black Hills and portions of the surrounding country; by F. B. MEEK and F. V. HAYDEN. 20 pp., 8vo. From the Proceedings of the Acad. Nat. Sci. of Philadelphia, March, 1858.—An abstract of this paper is given in the last volume of this Journal, pages 439, 440. Besides the subjects there referred to, it contains descriptions of several species of fossils, Tertiary, Cretaceous, and others from beds supposed to be Jurassic.

6. *Notice of Remains of Extinct Vertebrata from the valley of the Niobrara river;* by JOSEPH LEIDY, M. D. 10 pp., 8vo. From the Proceedings of the Acad. Nat. Sci. Philad., March, 1858.—The letter from Dr. Leidy, published on page 441 of the last volume of this Journal, contains an abstract of this highly interesting paper on the collections made by Dr. Hayden. The names of the species described are as follows:

Carnivora.

Canis sævus.
" temerarius.
" vafer.
" (Epicyon) Haydeni.
Felis (Pseudælurus) intrepidus.
Aelurodon ferox.

Rodentia.

Hystrix (Hystricops) venustus.
Castor (Eucastor) tortus.

Ruminantia.

Cervus Warreni.
Merycodus necatus.
Procamelus occidentalis.
Megalomeryx Niobrarensis.
Merycochoerus proprius.
Merychus (*Leidy*) elegans.
" medius.
" major.
Anchitherium (Hypohippus) affinis.
" (Parahippus) cognatus.
Equus excelsus.
" (Protohippus) perditus.
Merychippus (*Leidy*) insignis.
" mirabilis.
Hipparion s. Hippotherium occidentale.
" " speciosum.

Pachydermata.

Rhinoceros crassus.
Mastodon (Tetralophodon) mirificus.
Elephas (Euelephas) imperator.

In an appendix to this paper Dr. Leidy adds a statement of the additional discovery of two other species of *Camels* in the Niobrara region,—one of which he calls the *Procamelus robustus*, and the other *P. gracilis*. The former was about the size of the modern camel, and the other not larger than the Lama.

7. *Note on the Genus Graptolithus;* by JAMES HALL. (The Canadian Naturalist and Geologist, iii, 139.)—The observations of Mr. Hall are throwing great light on the characteristics of Graptolites. His specimens from New York, and the Canada Geological Survey are very numerous and various. In several, the Graptolites are much branched, and somewhat stellate in appearance, consisting of two nearly similar halves somewhat bifurcately divided in a plane, and proceeding from a common stipe and united together about the central parts by a membrane or corneous disk. Others are simple, and *show all the stages of growth from the simple young individual to the compound branched form.* The article in the "Canadian Naturalist and Geologist" describes and figures some of the branched forms, and is from Mr. Logan's forthcoming Geological Report. Mr. Hall thus characterizes the genus Graptolithus:

"*Description.*—Corallum or bryozoum fixed, (free?) compound or simple? the parts bilaterally arranged, consisting of few or many simple or variously bifurcating branches, radiating more or less regularly from a centre, and united towards their base in a continuous thin corneous membrane or disk, formed by an expansion of the substance of the branches, and which in the living state may have been in some degree gelatinous. Branches with a single or double series of cellules or serratures, communicating with a common longitudinal canal, affixed by a slender radix or pedicle from the centre of the exterior side."

"In its living state we may suppose it to have been concavo-convex (the *upper* being the concave side), or to have had the power to assume this form at will. In many specimens there is no evidence of a radix or point of attachment, and they have very much the appearance of bodies which may have floated free in the ocean."—p. 142.

He adds farther:

"It will appear evident from what follows, that heretofore we have been compelled to content ourselves for the most part, with describing *fragments* of a fossil body, without knowing the original form or condi-

tion of the animal when living. Under such circumstances, it is not surprising that various opinions have been entertained, depending in a great measure upon the state of preservation of the fossils examined. The diminution in the dimensions, or perhaps we should rather say in the development, of the cellules or serrations of the axis towards the base, has given rise to the opinions, advanced by Barrande, that the extension of the axis by growth was in that direction, and that these smaller cells were really in a state of increase and development. In opposition to this argument, we could before have advanced the evidence furnished by *G. bicornis*, *G. ramosus*, *G. sextans*, *G. furcatus*, *G. tenuis*, and others, which show that the stipes could not have increased in that direction. It is true that none of the species figured by Barrande indicate insuperable objections to this view; though in the figures of *G. Serra* (Brong.) by Geinitz, the improbability of such a mode of growth is clearly shown.

"It is not a little remarkable that with such additions to the number of species as have been made by Barrande, McCoy, and Geinitz, so few ramose forms have been discovered; and none so far as the writer is aware, approaching in the perfection of this character to the American species.

"Maintaining as we do the above view of the subject, which is borne out by well-preserved specimens of several species, we cannot admit the proposed separation of the Graptolites into the genera *Monograpsus*, *Diplograpsus*, and *Cladograpsus*, for the reason that one and the same species, as shown in single individuals, may be *monoprionidean* or *diprionidean*, or both; and we shall see still farther objections to this division, as we progress, in the utter impossibility of distinguishing these characteristics under certain circumstances. We do not yet perceive sufficient reason to separate the branching forms from those supposed to be not branched, for it is not always possible to decide which have or have not been ramose, among the fragments found. Moreover, there are so various modes of branching, that such forms as *G. ramosus* present but little analogy with such as *G. gracilis*.

"Mr. Geinitz introduces among the *Graptolitideæ* the genus *Nereograpsus*, to include *Nereites*, *Myrianites*, *Nemertites*, and *Nemapodia*. Admitting these to be organic remains, which the writer has elsewhere expressed his reasons for doubting, they are not related in structure, substance, or mode of occurrence, to the Graptolites, at least so far as regards American species; and the *Nemapodia* is not a fossil body, nor the imprint of one, but simply the *recent track of a slug* over the surface of the slates. The genus *Rastrites* of Barrande has not yet been recognized among American *Graptolitideæ*. These forms are by Geinitz united to his genus *Cladograpsus*, the propriety of which we are unable to decide.

"The genus *Gladiolites* (*Retialites* of Barrande, 1850, *Graptophyllia* of Hall, 1849) occurs among American forms of the *Graptolitideæ*, in a single species in the Clinton group of New York. A form analogous, with the reticulated margins and straight mid-rib, has been obtained from the shales of the Hudson River group in Canada, suggesting an inquiry as to whether the separation of this genus on account of the reticulated structure alone, can be sustained. In the mean time we may add that the Canada collection sustains the opinion already expressed, that the *Dictyonema* will form a genus of the family *Graptolitideæ*. The

same collection has brought to light other specimens of a character so unlike anything heretofore described, that another very distinct genus will thereby be added to this family. The Canadian specimens show that the Graptolites are far from always being simple or merely branching flattened stems."—pp. 140, 141.

These remarks are followed by descriptions of several species.

8. *Reminiscences of Arctic Ice Travel in search of Sir John Franklin and his companions;* by Capt. F. L. M'Clintock, R. N., *with Geological Notes and Illustrations;* by the Rev. Samuel Haughton, M. A., Prof. Geol. Univ. of Dublin. 68 pp., 8vo, with 9 plates and a colored Arctic geological map. From the "Journal of the Royal Dublin Society," Feb. 1857.—Capt. M'Clintock was in the Arctic under the command of Sir James C. Ross, on his expedition in search of Franklin, and afterwards in command of H. M. Screw-steamer Intrepid, under the orders of Capt. Kellett, C. B., of the Resolute.

He was connected with two sledging expeditions; the first, in 1849, started from Port Leopold, lat. 74° N., long. 90° W., in the northeast corner of North Somerset, and followed the north and part of the western shore of that large island; the second, in 1851, started from Griffith's Island, in lat. 74½° N. and 95½° W., and explored the southern part of Melville Island. In the summer of 1852 he was again at Melville Island in command of the Intrepid. From a port on the south side, Capt. M'Clintock crossed the island to the north and passed over also to Prince Patrick Land beyond, between 115° and 121° W., and 76° and 78° N., which he partially examined. The last excursion occupied 105 days and extended over 1400 miles.

The geological formations met with and colored on the map are as follows: the colored part of the map covers the area between 75° and 125° W. and between 72° and 78° N.

(1.) *Granitic or crystalline rocks:* over eastern North Devon, long. 80°—82½°, lat. 74½—75¾°; western North Somerset, near long. 95°; in scattered boulders over many other parts of the islands.

(2.) *Upper Silurian and Devonian:* over the northern part of Cockburn Island, 73°—73¾° N., and 75°—90° W.; the larger part of North Somerset; Cornwallis Island; all but the eastern part of North Devon.

(3.) *Carboniferous limestone:* over the islands or parts of islands lying *north* of lat. 76°, from Grinnell Land on the east (93° W.) to Prince Patrick Land on the west. This limestone is stated to *overlie* the coal-bearing sandstones.

(4.) The *Coal-bearing sandstones* (referred to Subcarboniferous): over the same islands as the limestone, but *south* of 76°; including Bathurst Land, 75°—76° N., 99½°—104° W.; Melville Island, from its southern shore to 75° 50′ N.; Byam Martin Island between Bathurst and Melville; part of Eglinton Id., west of Melville, south of 75° 50′; Baring (or Banks) Land, 72½°—74½° N., 115°—125° W.

(5.) *Jurassic rocks:* over a small peninsula on the eastern side of Prince Patrick Land; also at islets Exmouth and Talbe, north of Grinnell Land, in long. 95° W., lat. 77° 10′ N.

Viewing the range or direction of the whole, the line between the "*Carboniferous* limestone" and the "coal-bearing sandstones," according

to the map, is nearly straight between E. 5° N. and W. 5° S. In the coal-bearing sandstone region, two parallel outcrops of coal are marked as existing on Bathurst Land and southeastern Melville Island, and on the intervening island of Byam Martin, the distance between the two lines eight or ten miles; also a third outcrop in Melville Island, and along the same line in Baring Land to the southwest. The strike is represented as uniform between E.N.E. and W.S.W., and is deduced from the observed occurrence of coal at Cape Hamilton on Baring Island, Cape Dundas on Melville Island, also Bridport Inlet and Skene Bay on Melville Island; on Byam Martin Id.; and at Shomberg Point and Graham Moore Bay on Bathurst Island.

The following are the fossils observed—beginning at localities to the eastward.

(1.) *Silurian and Devonian.*

a. North Devon. Cape Riley (74° 40′ N., 92½° W.) *Favistella Franklini.*

b. Possession Bay (73° 30′ N., 77° 20′ W.) and Cape York (73° 50′ N., 87° W.), a brown earthy limestone, which at the latter place contained a coral near *Favosites Gothlandica.*

c. North Somerset.—At Garnier Bay (74° N., 92° W.), *Cyathophyllum helianthoides* of Goldfuss, *Heliolites porosa* (also in Devonian of England), *H. megastoma*, *Cromus Arcticus* (the trilobite *Encrinurus levis* of Anselm, according to Salter), *Atrypa Phoca* Salter, *A. reticularis*, *Columnaria Sutherlandi* Salter, various *Brachiopods*, and a *Cyathophyllum*.—At Port Leopold (73° 50′ N., 90° 15′ W.), *Calamopora Gothlandica!* ("unquestionably identical with the celebrated fossil of Goldfuss") *Rhynconella cuneata*, and a *Cyathophyllum*; *Loxonema M'Clintocki.*

d. Beechy Island (74° 40′ N., 92° W.).—*Atrypa Phoca* (*Rhynconella Phoca* of Salter) abundant, *Atrypa* ———, an *Orthoceras*, many species of *Loxonema*, forming sometimes a Loxonema limestone, Crinoidal limestone, *Clisiophyllum Austini*, *Chætetes Arcticus*, *Syringopora reticulata*, *Calophyllum phragmoceras*, *Cyath. cæspitosum*, *C. articulatum*, (Edw. and Haime), *Fav. Gothlandica?*, *F. alveolaris?*, *Favistella Franklini.*

e. Griffith's Island (74° 35′ N., 95° 30′ W.).—*Cromus Arcticus*, *Orthoceras Griffithi* Haughton, an *Orthoceras* with lateral siphuncle and simple circular outline of septa, *Loxonema Rossi*, *Strophomena Donnetti* Salter, *Calophyllum Phragmoceras* Salter, *Syringopora geniculata*, *Macrocheilus* ———? Crinoidal limestone.

f. Cornwallis Island (74° 40′ N., 94° W.).—*Orthoceras Ommaneyi* Salter, *Pentamerus Conchidium* Dalman, *Cromus Arcticus*, *Cardiola Salteri*, *Syringopora geniculata* (also found in the Irish Carboniferous).

(2.) *Coal-bearing Sandstone of Lower Carboniferous.*

a. Bathurst Island.—Graham Moore's Bay (75° 30′ N., 102 W.). *Coal* of the usual quality.

b. Byam Martin Id. (75° 10′ N., 104° 15′ W.)—An *Atrypa* near *A. primipilaris* of v. Buch and the *A. fallax* of the Carboniferous rocks of Ireland in a yellowish gray sandstone. *Coal.*

c. Melville Island.—Cape Providence (74° 20′ N., 112° 30′ W.), Crinoidal limestone, apparently like that of Griffith's Island; yellowish gray sandstones; clay ironstone.—Winter Harbor (74° 35′ N., 110° 45′ W.). Yellow and gray sandstone.—Bridport Inlet (75° N., 109° W.). *Coal* with impressions of *Sphenopteris*, clay ironstone.—Skene Bay (75° N., 108° W.). *Bituminous Coal*, associated with brown crystalline limestone, and grayish yellow and reddish sandstone.—Hooper Island (75° 5′ N., 112° W.). Clay ironstone, sandstone and *Coal*.—Cape Dundas (74° 30′ N., 113° 45′ W.). Fine specimens of *Coal.*

d. Baring Island.—Ballast Beach (74° 30′ N., 121° W.). Wood fossilized by brown hematite.—Princess Royal Islands (72° 45′ N., 117° 30′ W.). Clay ironstone, brown hematite (pisolitic), grayish yellow sandstone, *Terebratula aspera* Schlotheim (abundant in the Eifel); native copper from the Esquimaux.—Cape Hamilton, grayish yellow sandstone, like that on Byam Martin's Island, *Coal.*

(3.) *Carboniferous limestone.*

a. Bathurst Island, north coast, at Cape Lady Franklin (76° 40′ N., 98° 45′ W.) *Spirifer Arcticus* Haughton, *Lithostrotion basaltiforme.*

b. Melville Island.—Hillock Point (76° N., 111° 45′ W.). *Productus sulcatus* (also European), *Spirifer Arcticus.*

(4.) *Jurassic.*

Prince Patrick's Land.—Wilkie Point (76° 20′ N., 117° 20′ W.). *Ammonites M'Clintocki, Monotis septentrionalis, Pleurotomaria* ——? *Nucula* ——?

A review of what was previously known on Arctic geology is given by A. K. Isbister in the Quarterly Journal of the Geological Society, vol. xi, p. 497 (1855), and the paper is cited in this Journal, vol. xxi, p. 313–338 (1856). This article gives also a list of previous publications on the subject.

One of the most important results brought out is the seeming establishment of the conclusion, long since announced, that the sea temperature of the Arctic zone in the Silurian, Devonian and Carboniferous ages, was not essentially different from that in the temperate zone. The study of the geographical distribution of animals is showing that species have but a narrow range of temperature in which they can flourish in full vigor, and even families and tribes have often but a limited range. 20° F. (between 68° and 88°) is the whole range of the existing coral reef corals —and species have still more restricted limits. The existence therefore of the same species of corals, molluscs and trilobites, or of *closely related or representative*, if not identical, species, in latitudes 40° and 75°, leads to but one conclusion. The near uniformity of the climate is at once suggested, and must be admitted until this life-thermometer reads otherwise. Whether the relative size of related species indicates a degree of difference is yet undetermined.*

The Jurassic fossils extend the same approximate uniformity onward to the Jurassic period, or prove a recurrence of it, if it had been interrupted. The Ammonite, *A. M'Clintocki*, is stated to approach the *A. concavus* of the lower Oolite. The author remarks on page 41, "The fossils are all small, and of only a few varieties, some being Ammonites, but the greater part bivalves." "I picked up also what appeared to be a fossil bone (*Ichthyosaurus?*) only part of it appearing out of the fragment of the rock." The *supposed* Ichthyosaurian bone was afterwards lost. Jurassic fossils have also been found at Katmai Bay or Cook's Inlet in northwest America (60° N., 151° W.); and Dr. Grewingk mentions the species as *Ammonites Wosnessenski*, *A. biplex?* (the *A. biplex* of Mayen from Jurassic deposits in the Andes in latitude 34°, south of Valparaiso, is stated to be not distinguishable from this), *Belemnites paxillosus*, and *Unio Liassinus*. Professor Haughton remarks upon the fossils of Prince Patrick's Land (p. 62), "The discovery of such fossils *in situ* in 76° north latitude, is calculated to throw considerable doubt upon the theories of climate which would account for all past changes of temperature by changes in the relative position of land and water on the earth's surface. No attempt, that I am aware of, has ever been made to calculate the number of degrees of change possible in consequence of changes of

* The facts plainly show that the argument employed on pages 78, 79 of this number by Mr. Stevens is defective. Moreover there was not only a wider uniformity of climate at that early period, but also greater comprehensiveness in all the earth's conditions and changes.

position of land and water; and from some incomplete calculations I have myself made on the subject, I think it highly improbable that such causes could have ever produced a temperature in the sea at 76° north latitude which would allow of the existence of Ammonites, especially Ammonites so like those that lived at the same time in the tropical warm seas of the south of England and France, at the close of the Liassic and the commencement of the lower Oolitic period."

9. *Descriptions of New Tertiary Fossils from Oregon and Washington Territories, and new Cretaceous species from Vancouver's Island, collected by Dr. Evans;* by Dr. B. F. Shumard, (Trans. Acad. Sci., St. Louis, 1858, p. 120).—The Tertiary species are *six* in number, the Cretaceous *two*. The latter are *Inoceramus Vancouverensis* and *Pinna Calamitoides*. They are stated to occur with a *Nautilus* (apparently identical with *N. DeKayi* of Morton and other species) in an argillaceous limestone.

10. *Report of a Geological Reconnaissance in California*, made in connection with the Expedition to survey routes in California to connect with the surveys of routes for a railroad from the Mississippi river to the Pacific Ocean, under the command of Lieut. R. S. Williamson, Corps Top. Engineers in 1853; by Wm. P. Blake, Geologist and Mineralogist of the Expedition. With an Appendix containing descriptions of portions of the collections by Prof. L. Agassiz, A. A. Gould, M.D., Prof. J. W. Bailey, T. A. Conrad, Prof. John Torrey, Prof. George C. Schaeffer, J. D. Easter, Ph.D. 336 pp., 4to, with numerous wood-cuts and 4to plates. New York, 1858. H. Bailliere.—This volume is a separate publication (with some corrections) of a part of the fifth volume issued by the general government, on the subject of the Explorations and Surveys for a Railroad route from the Mississippi River to the Pacific Ocean. Mr. Blake by his explorations has been enabled to make important contributions to our knowledge of both the topography and geology of California. The Report commences with an "Itinerary or notes and general observations upon the geology of the route." He then takes up the "Geology of portions of the Route,—of the vicinity of San Francisco and Monterey,—the Tulare valley,—the Tejon Pass and Cañada de las Uvas,—the southern part of the Great Basin,—the Colorado Desert,—closing with notes on the Gold Region. Some notice of the observations on the orography was given in our last number; and in previous volumes we have published part of the results of Mr. Blake's observations either in notices of his preliminary publications or in communications from himself. These notices are as follows: on the Colorado Desert, vol. xvii, p. 438; on the Cinnabar mines, xvii, 438; review of preliminary Report, xix, 433; on the Gold region of California and its minerals, xx, 72; on the grooving of rocks by sand, xx, 178; descriptions of fossil shells collected in California, from the Tertiary (Eocene and Miocene) by T. A. Conrad, with remarks in conclusion on the Tertiary by Mr. Blake, xxi, 268; notice of fossil fishes collected in California by Mr. Blake, by L. Agassiz, xxi, 272; evaporation at the Tulare lakes in California, xxi, 365; and also observations on Marcou's geological map, xxii, 383. We might still quote from the volume at great length to the advantage of our readers, but it is not necessary, as it is now made accessible to geologists by the author, through a separate publication. Besides numerous views,

maps and sections, there are the following plates—1 of fossil shark's teeth to illustrate Agassiz's appendix; 11 of Eocene and Miocene Tertiary shells, by Conrad; 1 of sections of silicified wood, by G. C. Schaeffer; 10 of new species of plants described by Dr. Torrey.

11. *On the parts of California and Oregon explored by* Lieut. R. S. Williamson, Topog. Eng., and Lieut. H. L. Abbott, Topog. Eng., in 1855, being the sixth volume of the Reports of Explorations and Surveys to ascertain the most practicable and economical route for a railroad from the Mississippi river to the Pacific Ocean.—This volume commences with the General Report by Messrs. Williamson and Abbott, presenting important observations on the general topography, productions and inhabitants of the country examined, and special details relating to the proposed railroad route. Among the statements we find that Shasta Peak is estimated at 18,000 feet in height above the sea, and that its two peaks are "loaded with eternal snow." It is of interest to compare with this the aspect in October, 1841, as sketched with minute attention to the position of the snow by J. D. Dana, and published in this Journal, vol. vii, p. 249. From the amount of snow there shown, it is plain that the height is less than 14,000 feet. It is stated in the text that the peak was seen early in November, and it snowed there on the night of November 9th; whereas in 1841 there had been no snow or rain during the autumn until the time of the visit.

This Report is followed by a Geological Report by Dr. J. S. Newberry, Geologist and Botanist of the Expedition. The following facts are cited from its pages.

San Francisco Sandstone.—The San Francisco sandstone and shale, which in some places pass into talcose slate and jasper rock, are referred to the Tertiary, as done by Mr. W. P. Blake, and the associated serpentine is regarded as probably eruptive. An analysis by J. D. Easter shows that it is common serpentine in composition. No fossils have yet been found to place beyond doubt this reference of the slates and associated rocks to the Tertiary.—A *Scutella* (*S. interlineata*) is washed up on the shores, on the Pacific side of the San Francisco axis, and it is supposed on lithological grounds that the rock (a sandstone) as well as the fossiliferous Miocene sandstones to the eastward, is the same in age as that about San Francisco.

At *San Pablo Bay*, the Miocene sandstone dips 30° to 35° to the eastward; it consists of sandstones overlaid by fossiliferous beds, these by other sandstones and shales without fossils, and these by conglomerates and tufas. The fossils are species of Pecten, Mactra, Nucula, Tellina, referable to the Miocence according to Conrad. Above the whole lies a horizontal layer of oyster shells four feet thick, about twenty feet above the present water level. The oyster is a living species. The same sandstone formation is continued through the Straits of Carquines, as others have described, and occurs also about Benicia, where shark's teeth were collected by Mr. Blake. A jasper hill occurs five miles from Benicia, which resembles the jasper rock near San Francisco; and at the north end of the ridge there is a copious spring, slightly thermal, the temperature 80° to 90° F.

Mount Diablo is partly made of Miocene Tertiary strata abounding in fossils. There are also serpentine rocks, actinolite, diallage; and gold has been found in the streams running from the mountain.

There is a mystery as to the connection between the metamorphic rocks, including talcose slate, serpentine, talc, actinolite and jasper rock of the coast region, and the fossiliferous sandstone, which remains to be solved. There are serpentine and actinolite associated with the talcose slates on the north side of the Bay of San Francisco which were not a product of eruption, as we know from observation; and it appears to us altogether improbable that any of the serpentine is eruptive. There is a problem here for future investigation. The hot springs of Wam Chuck valley (see beyond) afford a hint on the subject.

Cretaceous (?) strata on Chico Creek, northern part of the valley of the Sacramento.—A calcareous sandstone on Chico creek in the foot hills of the Sierra Nevada, as first described by Dr. Trask, contains species of the genera *Mactra*, *Tellina*, *Nucula*, *Fusus*, *Turritella*, *Natica*, etc., along with *Baculites* and *Ammonites*. Two of the species, a *Nucula* and *Mactra*, according to Conrad, are very similar to miocene fossils of Astoria on the Columbia, the *N. divaricata* and *M. albaria*;* and these have been regarded as proving that the deposits, although containing Cretaceous genera, are Tertiary. But Dr. Newberry observes that it is more probable, as all the other species are undoubtedly new, that these also are so, and that the deposits are Cretaceous. Above Chico Creek the Sacramento valley rapidly narrows.

Volcanic Cone near Bear Creek.—A cone 500 or 600 feet high occurs in Bear Creek Valley, near Fort Reading. It has a crater and there are lava streams in its vicinity, and much obsidian with tufa deposits.

Cretaceous and Carboniferous fossils near Fort Reading.—Dr. Trask has described a fine Ammonite from a locality a few miles southwest of Fort Reading under the name of *Ammonites Batesii*, collected by Dr. Bates.

East of north of this fort the mountains contain limestone strata of the Carboniferous age, having great thickness. They were first mentioned by Dr. Trask. The fossils are *Spirifers*, species of *Orthis*, *Encrinal* stems, and *Cyathophylloid corals*.

Mt. Shasta—Lassen's Bute—Coal.—Mt. Shasta and Lassen's Bute connect with the Sierra Nevada and bound the elevated plateau of the interior; the eastern base of these mountains, being 4000 feet higher than the western. At McCumber's, 25 miles beyond Fort Reading, good *coal* has been found, according to Mr. McCumber. The plateau is about 4000 feet above the sea. Dr. Newberry saw no specimens.

Lassen's Bute is a volcanic cone, about 9000 feet high, and feldspathic lavas covered the region around.

Three Sisters.—In the vicinity of the parallel of 44° by the head waters of the Des Chutes river, the Three Sisters were near by—really five in number; the highest 10,000 to 11,000 feet in height, the group stands at an angle in the Cascade range. While standing at the pass,—to the north the snow-clad peaks of Mt. Jefferson and Mt. Hood were in sight,

* See Expl. Exp. Report by J. D. Dana, Appendix on the Fossils of Astoria by Mr. Conrad.

to the southwest-by-south appeared Mount Pitt, and then south from this peak, Mt. Shasta; from Mt. Shasta, the range was deflected eastward to Lassen's Bute, and thence stretched on south again. The axis of the Cascade range is set nearest to its western limit; the declivities eastward are few and steep, while westward there is a broad mountainous belt, gradually diminishing in altitude. Besides the lofty cones, there are many other craters along the range. Between the snowy mountains of the Three Sisters, a large crater and recent lavas were passed at a height of 6,500 feet above the sea.

Glacial action.—The north wall of this crater consisted of black porphyry, and was everywhere scored as if by glacial action. The groovings continued down the northwest and southwest sides of the mountain and in the latter direction they were traced for several miles to a point over 2000 feet below the line of perpetual snow. These evidences of glacial action reach over a wide extent of country and prove a condition of climate in former times widely different from the present.

Des Chutes Basin.—This basin consists of a series of plateaus from 4000 to 2200 feet in elevation above the sea, each covered usually by a floor of columnar igneous rock. The igneous rock overlies tufas and conglomerates neatly stratified, and alternates at times with other doleritic layers. At the eastern base of the Three Sisters, the plateau is 4000 feet high. The evidences of igneous action were seen in lava streams, besides a cone of scoria, and Mt. Jefferson with its ejections. Approaching Mt. Jefferson, the progress of the party was arrested by a cañon 1950 feet deep: standing on one side on metamorphic slates, they looked across to the black and rugged slopes of the great snow-covered mountain.

The tufas were partly of white, pink, blue and other fancy colors; some varieties were highly infusorial, and *freshwater* in species, according to Prof. Bailey. They contained numerous trunks of trees, sometimes fossilized and sometimes in the condition of decayed wood.

Hot Springs. Metamorphic action.—In the valley of the Wam Chuck there are numerous hot springs, two of them having a temperature of 143° and 145° F. The water holds large quantities of dissolved silica, and gelatinous silica was floating in it; the sides of the springs were incrusted with a siliceous deposit. The tufa cliffs are intersected by steam from fissures and the hot waters, and the layers are so changed as to resemble "serpentine or some light colored volcanic or metamorphic rock which has undergone complete fusion." The extreme form of metamorphism is a variety of *jasper*. The pumiceous tufas first have the cement hardened, and semicrystallized; then the whole takes a buhrstone aspect, the space occupied by the pumice being empty or nearly so; finally, at the third stage of change, the cavities are filled with onyx in horizontal layers of red, white and green colors, or with opal, or more rarely agate. The results arise evidently from the hot siliceous waters acting on the tufas and marls. Silicified wood is very abundant, as it is over much of Oregon and California.

Infusoria.—Infusorial remains were collected in the basins of Pit river, Klamath, the Des Chutes and the Columbia, as well as at Monterey, and many other points on the coast, to Shoalwater, Washington Territory. Prof. Bailey found in every case that all the specimens from the east of

the Cascade or Sierra Nevada were of *freshwater* species of Diatoms, while those from near the coast were marine. In the stratified tufas and conglomerates of the interior no animal remains but infusorial were found.

Mount Hood (*South side of the Columbia*).—Showers of ashes have been discharged several times from Mt. Hood since the country was settled by the whites. Mr. Dryer of Portland who attempted the ascent in 1854, states that steam and heated gases were escaping from its summit in many places at the time of his visit.

We have thus culled a few facts from Dr. Newberry's valuable geological report. It is accompanied by descriptions of Tertiary fossils by Mr. Conrad, from California and the Isthmus of Darien: and it is followed by a second Report by Dr. Newberry on the Botany of the route, illustrated by plates.

12. *Report on the Explorations in California to connect with the routes near the 35th and 32nd parallels, and also the route near the 32nd parallel between the Rio Grande and Los Pimas villages;* by Lieut. JOHN G. PARKE, Topog. Eng., in 1854 and 1855; being the seventh volume of the Reports of Explorations and Surveys, &c., over the Rocky Mountains.—The General Report of Lieut. Parke occupies the first 40 pages of this volume, and is then followed by the *Geological* Report of THOMAS ANTISELL, M.D., Geologist of the Expedition, covering 196 pp., 4to.—The geological examinations of Dr. Antisell in Southern California extended over the counties Santa Cruz, Monterey, San Luis Obispo, Santa Barbara and Los Angeles. He commences with a general account of the Coast ranges. He mentions the parallel ranges south of San Francisco. The *first* along the coast, is the Santa Cruz range, having in Santa Cruz and Santa Clara an average altitude of 2000 feet: the length 85 miles; strike N. 70° W. The *second* range extends from the southern shores of San Pablo and the straits of Carquines; in Alameda county and Santa Clara, its altitude is as great as for the Santa Cruz range. The *third* is the Mount Diablo range. Mt. Diablo is near 55 miles inland, and has a height of 3800 feet. The range is not a continuous one, it dropping down occasionally to low hills. East of this range is the valley of San Joaquin; and beyond this, the Sierra Nevada.

The counties of Santa Barbara, Los Angeles and San Diego are remarkably subject to earthquakes; the average number for the last six years is more than nine a year.

In the southern part of California no strata have been found between the Tertiary and the crystalline rocks in age. Dr. Antisell remarks that "there is no good evidence that the southern portions of California were so circumstanced as to receive any of the mud or siliceous deposits of the palæozoic age." But this is an unwarranted inference; for it is by no means improbable that the crystalline rocks are the palæozoic strata metamorphosed.

The Tertiary of these southern counties is Miocene in age, and is divided between two or three epochs—(1) "that of the deposition of the brown sandstones with traces of lignite as in the sandstones of Monte Diablo and Gavilan; (2) the calcareous beds of the valleys, as at Santa Margarita and the Estrella valley: and (3) the quartzose, bituminous and polythalamous beds of the coast. The first or lower are estimated to have a

thickness of 1200 feet, the middle of 610, and the upper of 400 feet, making in all 2211 feet. The Tertiary of the Estrella valley, Santa Inez mountains and San Raphael hills, Mr. Conrad states, is parallel with that of the James and York rivers in Virginia; there are gigantic Pectinidæ in each and the *Pecten Magnolia* of the Pacific Tertiary may be identical with *P. Jeffersonius* of Virginia. This Estrella Tertiary is probably of later age than the Santa Barbara. Mr. Conrad adds, "I have no doubt that the Atlantic and Pacific oceans were connected in the Eocene period; and the fossils herein described afford strong evidence that the connection existed during the Miocene period." All the species of Tertiary fossils, except perhaps two, differs from those found by Mr. Blake.

Chapter 17 of the Report closes the observations on Southern California, and after it follows chapters on the geology of the interior region along from San Diego to Fort Yuma and thence to the Pimas villages. Gypsiferous beds were met with south of the Gila and east of its tributary, Rio San Pedro, in 110° 30′ W., which are referred to the Cretaceous, but no fossils were found to remove all doubts.

The Report is illustrated by sections and two maps, but the sections are much distorted and seem to be generally a result of very hasty observations.

13. *Descriptions of New Species of Blastoidea from the Palæozoic rocks of the Western States, with some observations on the Structure of the summit of the Genus Pentremites;* by B. F. Shumard, M.D. 12 pp., 8vo, with one copper-plate. Ext. from Acad. Sci., St. Louis, Vol. I, No. 2.—This paper describes two new species of *Codaster* and three of *Pentremites*. The author shows that the mouth aperture and the ovarial apertures around it are each covered by a group of small calcareous plates. The paper closes with a table of the genera and species of the family Blastoidea found in the western and southern portions of the United States, including twenty-one species of *Pentremites*, three of *Codaster* (M'Coy), and one of *Eleutherocrinus* (Shum. and Yan.) *Three* of the *Pentremites* are from the Upper Silurian (Lower Helderberg group); *two* from the Devonian (one from the Upper Helderberg and one from the Chemung); and the rest from the Carboniferous (Sub-carboniferous period); eight of them in the Encrinal limestone, and eight in the Archimedes limestone. Of the species of *Codaster*, two are Devonian (Upper Helderberg) and one Carboniferous (Encrinal limestone). The species of *Eleutherocrinus* is from the Upper Helderberg.

14. *New Trilobites from the Lower Silurian rocks of Canada;* by E. J. Chapman, Prof. Min. and Geol., University College, Toronto. 9 pp., 8vo, with a wood-cut. (Canadian Journal, Toronto, for May, 1858.)—The author describes two large species of Asaphus, both new, the *Asaphus Canadensis* and *A. Halli*. The former occurs in the Utica shale of the townships of Whitby and Nottawasaga, Canada West. The largest specimen was five inches in length. The second species, *A. Halli*, is from the Trenton limestone of Peterborough, and one of the specimens is six inches long.

15. *On the Assaying of Coals by the Blowpipe;* by E. J. Chapman. 12 pp., 8vo. (Canadian Journal, Toronto, for May, 1858.)—This is an important paper, giving, with much detail and precision, methods for

determining the volatile ingredients, coke, ash, sulphur, &c., of mineral coals by means of the blowpipe alone.

16. *On the Parallelism between the Deposits of Auriferous Drift of the Appalachian Gold-field and those of California;* by WILLIAM P. BLAKE. (From a letter addressed to J. D. DANA, dated Dahlonega, Ga., April, 1858.)—I have just completed a tour of exploration in the gold region of North Carolina and Georgia, and am much impressed with the close similarity of the gold deposits to those of portions of California. The great difference between the two regions appears to be in the scale upon which they are developed. In California the mountains are higher, the streams larger, the river-valleys deeper, the gold-drift heavier, and the gold coarser and more abundant than in Georgia. But though there is this difference in the scale of development, the similarity is preserved in the configuration of the surface and in the distribution of the gold. In topography the elevated and undulating surface of the Cherokee lands in Lumpkin county, Georgia, much resembles the "divides" or elevated lands between the forks of the American River in California. The hills are formed of gneiss and mica slate on edge, traversed with auriferous quartz veins, and covered with beds of drift as in California. Gold occurs not only along the streams in gravel, but is found high on the hills under accumulations of river-drift, gravel and clay. It is evident in Georgia, as in California, that the rivers once ran at a much higher level, even on the tops of the present hills. River-gravel and gold is found here from 200 to 300 feet above the streams. Many of these deposits on the hills give evidence of great richness but have never been worked, owing to the distance of the earth from water and the expense of excavating and carting it to the rivers. Owing also to the difficulty of prospecting these high places, without water at hand, their value has never been fully known or appreciated.

In North Carolina the elevated placers are now being washed by the hydraulic method with great success. Through the energy and perseverance of Dr. M. H. VanDyke, a former resident of California, water is supplied to them by a canal several miles in length, winding about on the sides of the hills, and at one point the water is carried across a valley, more than half a mile wide, in a flume supported upon trestles one hundred feet above the ground. This water is delivered at such a height above the placers that they are rapidly washed away before the jets, and the gold is thus secured.

The gold from these placers is not as coarse as in most of the high placers of California, but it is similar in the form of the particles. Black sand is very abundant and coarse, and contains zircon, corundum, kyanite, garnets and other minerals not yet determined.

17. *On Tennessee Geological History;* by Prof. JAMES M. SAFFORD. (From a letter to J. D. DANA, dated Lebanon, Tennessee, March 31st, 1858.)—There is an example of unconformability between the Lower and Upper Silurian in Tennessee which has not attracted the notice it deserves. There appears to have been an island in the Upper Silurian and Devonian seas, occupying about a central position with reference to the present limits of the State. This island was perhaps 80 or 90 miles in diameter. It was elevated apparently at the close of the Lower Silurian

age, and was then not under the sea again until the commencement of the period during which the "black slate" was deposited. Such I infer to be the case from the following facts:

1st. Within an area which I know to be from 40 to 50 miles from east to west and about 80 from north to south, the black slate, wherever it is exposed, rests directly upon rocks of the Hudson period, the intermediate upper Silurian and Devonian beds being absent. This may be seen in part by referring to my geological map of Tennessee.

2d. Where the absent rocks first appear around the area mentioned they have an inconsiderable thickness, often but a few feet, thinning out, in fine, as we approach the supposed ancient land, and thickening slowly and uniformly in the opposite direction, thereby separating more and more the black slate and lower Silurian rocks.

3d. No evidence of the denudation of the absent rocks, previously to the deposition of the black slate has been observed.

Upon the whole I think there is good reason to believe that such an island or dry land existed. It was most likely low—a depressed dome, but little above the water. The sea around it was shallow, slowly deepening, as the distance from the land increased. On the west and south sides of this land, limestones for the most part were deposited; while on the north and northeast sides there was a much larger proportion of shale and sandstone. The materials of these deposits came perhaps from the northeast, the sand and heavier parts falling first, the calcareous and finer portions being carried farther, perhaps around the island to its west side, &c. However, take what view of it we may, these beds referred to afford an interesting example of unconformability between the lower Silurian and the formations above.

18. *Permian in Illinois.*—The existence of the Permian in Illinois has been recently recognized by Prof. James Hall from specimens received by him from Mr. Worthen. The following letter from Dr. J. G. Norwood, relating to the same region, has been published in the Proceedings of the St. Louis Acad. Sci., 1858, 115.

"I beg leave to submit for the consideration of the Academy the following remarks on some of the rocks of Illinois, which overlie the main Coal Measures in several counties of this State.

In 1855–6, while making examinations in the La Salle coal-field, I found in the upper beds a number of organic remains which were entirely new to me, but belonging mostly to genera liberally distributed through the Coal Measures of this and the neighboring States. Being associated with Coal-Measure fossils and intimately connected with beds of coal, they were considered to belong to the true Carboniferous era. In the winter of 1856, I caused drawings to be made of some of them, with the intention of describing them in connection with the late Mr. Henry Pratten. Since his death these drawings have not been found. Last summer Mr. H. A. Ulffers wrote out descriptive notes of several new *Producti* and *Chonetes* from the localities alluded to, to be used in a small monograph on *Producti* and *Chonetes* which I was then having printed, but which still remains unfinished.

My attention was not especially directed to a comparison of these fossils with organic remains peculiar to rocks of the Permian system, as

established by Sir Roderick Murchison and other European geologists, until since the announcement, made by Prof. Swallow, of Missouri, of the existence of Permian rocks in the Territory of Kansas, which was soon followed by the publication of the same fact by Mr. F. B. Meek and Dr. F. V. Hayden. Having thus had my attention directed to this subject, after a review of some of the fossils found in Bureau, La Salle, and Henry counties, I have become satisfied that the upper beds at least of the La Salle rocks are of the same age as those containing many of the organic remains described by the gentlemen above named as belonging to the Permian rocks of Kansas.

Among the fossils are *Pecten Cleavelandicus* Swallow, *Mytilus squamosus* Sow., *Productus Norwoodii* Swal., *Monotis radialis?* Phil., *Edmondia Murchisonia?* King, *Leda* (*Nucula*) *subscitula* Meek and Hayden. In a paper which I am preparing for the Academy, the whole fauna of these rocks will be noticed so far as I am acquainted with it, and a comparison instituted between that and the underlying Coal Measures. In the mean time, I enclose a vertical section of the rocks at one point in La Salle County.

The beds are composed of sandstones and conglomerates, magnesian limestone, slates, and red and blue gypseous marls, all of them resting unconformably on the underlying beds. In addition to the beds named, three thin seams of coal occur in the rocks alluded to as seen in the section: thus showing, that, if this formation shall be proved to belong, undoubtedly, to the Permian period, the great probability is, that the upper beds of coal in several sections of the State are of the same age. This is rendered almost certain from the very partial examination I have been able to make of the organic remains from other localities. I may also mention the occurrence in the slates of scales of a *Platysomus*, a genus that belongs to the Permian epoch.

Section of the rocks at La Salle—descending.

No.	ft.	in.
1. Bluish and reddish clay shales,	14	8
2. Limestone (brecciated),	15	8
3. Gray shale, irregular,	4 to 6	
4. Gray compact limestone, fossiliferous,	14	9
5. Black slate, irregular,	6	
6. Shaly limestone, very irregular in thickness,	8	
7. Coal,	1	
8. Limestone,	26	8
9. Shale, gray,	1	
10. Gray limestone,	7	
11. Gray shale,	5	
12. Blue limestone,	5	
13. Black slate,	7	
14. Coal,	5	
15. Blue shale,	9	5
16. Limestone,	1	6
17. Coal,	1	
18. Fire clay,	3	
19. Shale,	9	3
20. Limestone,	3	5
21. Coal,	1	
22. Fire clay,	3	
23. Blue shale,	17	1
24. Gray limestone,	3	5
25. Blue shale,	9	5
26. Gray limestone,	2	5
27. Blue shale,	12	
28. Blue limestone,	2	
29. Blue shale,	1	
30. Black slate,	2	5
31. Blue shale,	13	
32. Hard limestone,	4	
33. Blue shale,	2	7
34. Blue limestone,	5	
35. Red shale,	2	
36. Limestone,	3	
37. Red shale,	4	5
38. Brown shale,	10	
39. Sandstone,	18	
40. Siliceous shale,	19	
41. Slaty shale,	11	5
42. Black slate,	6	
43. Coal,	4	5

This section embraces only a portion of the rocks of La Salle, while in Bureau County, beds occur which overlie all those here given.

I will forward to the Academy, as soon as completed, a notice of the geology of that region, together with that of such other sections of the State as appear, from a comparison of their fossils, to be of the same age.

Springfield, Ill., March 31, 1858."

19. *Report on the Survey of South Carolina*, being the Second Annual Report to the General Assembly of South Carolina, embracing the progress of the Survey during the year 1857; by OSCAR M. LIEBER. 142 pp., 8vo, with plates and maps. Columbia, S. C.—After an introductory chapter, on veins and mining, this Second Report by Mr. Lieber takes up the geology of Union and Spartanburg Districts in South Carolina, which is illustrated, for each, with a colored map. The order in the rocks recognized is the following, commencing above: I. Blue limestone; II. *Itacolumitic* Group, including, *a.* Itacolumite, *b.* talcose slate and Catawbarite, *c.* white or mottled limestone, *d.* itacolumite, *e.* itabirite and specular schist, *f.* itacolumitic conglomerate and fine grained itacolumite; III. Group below the itacolumite, *a.* clay slate, *b.* talcose slate, *c.* mica slate, *d.* gneiss.—Besides these there are the *igneous* rocks, which are divided into the *granitic* and "*trappean*," the former including granite and eurite, the latter diorite, aphanite, minette, aphanitic porphyry, schistose aphanite, dioritic slate, saponite (meaning soapstone). We suspect that even the granite and diorite, as well as most of the other so-called trappean rocks will turn out to be metamorphic, like mica slate and gneiss, when the geology of the region has been more studied. The *aphanite* (which is made identical with *melaphyre*,) is, *in part* at least, a true trappean rock and resembles the dolerite or trap of New England. But the schistose aphanite is described as scarcely distinguishable from hornblende slate, and as possibly metamorphic. There seems to be little reason to doubt its metamorphic origin. The gneiss is described as differing but slightly from the granite in structure, but as containing less of hornblendic beds. There are very few if any valuable mineral veins in the gneiss. The mica slate contains the Cameron Galena mine and the iron mines at the Cowpens and at the Hurricane Shoals. Over the clay slate lies the itacolumite. At the top of Gilkey's Mountain, in Northern Union, Mr. Lieber found this rock passing into a coarse sandstone and conglomerate, showing that itacolumite is throughout a metamorphosed sandstone; some of the pebbles of the conglomerate are an inch and a half in diameter. The best specimens of the flexible variety may be obtained near Limestone Springs in Spartanburgh District. Gold has never been found in the itacolumite of South Carolina. With the itacolumite occurs the *Catawbarite*, a talc rock containing magnetic iron ore in lenticular beds; the *specular schist*, a quartzose mica schist consisting largely of specular iron; and *itabirite*, a similar rock containing as largely of magnetic iron. The iron ore is of excellent quality and in great abundance. The author describes with valuable detail the mines of gold, copper, lead and iron of the regions, and treats also in a following chapter of the soils and agriculture. The maps are neatly colored, and instructive.

20. *Preliminary Report on the Geology and Agriculture of the State of Mississippi;* by L. HARPER, LL.D., State Geologist of Mississippi.

By order of the Legislature of Mississippi. 350 pp., 8vo, with plates of sections. Jackson, Miss., 1857.—This Geological Report on Mississippi is very unequal in its different parts, and requires a careful revision before it can become good authority. Many of the sections have a fantastic boxing off of layers, which is untelligible to us. Certain rocks are pronounced to be Carboniferous, because the genus *Productus*, occurring in them, is not known to exist, the author says, in older strata. Some peculiar concentric aggregations in clay are attributed to whirlpools in the waters. The work argues against the subdivision of the Eocene proposed by Conrad, on very insufficient data, and an evident want of appreciation of the subject. There are errors also in the identification of the Cretaceous, Tertiary, and Post-tertiary beds, which betray insufficient observations and an imperfect acquaintance with the science.

The survey of the State of Mississippi is now vigorously prosecuted by Mr. EUGENE W. HILGARD.

21. *Description of a New Genus of Fossil Edentate;* by L. NODOT, Director of the Museum of Natural History at Dijon. 176 pp., 8vo, in the Mem. de l'Acad. Imp. des Sci, etc., de Dijon, 5th volume, 2d series. —This elaborate paper besides describing a new genus near Glyptodon, announces several new species of the genus Glyptodon, and brings out some general views on classification. Besides, it is illustrated by twelve fine lithographic plates in 4to. The new genus is called *Schistopleurum*. In *Glyptodon* the tail is inflexible and conico-cylindroid in form; in *Hoplophorus* it is inflexible, short, and massy in form; in *Schistopleurum* it is long, flexible, and verticillate. The two new species of Schistopleurum are *S. typus* and *S. gemmatum*. The form is very convex, or oblong globular, the length in the former in a straight line 1·68 meters, the breadth 1·21. The *Glyptodon tuberculatus* is a third species. The number of new species, of Glyptodon proposed is six, besides which, the author mentions three described by Owen. These fossil Edentates are all from the Pampas of southern South America in the vicinity of Buenos Ayres and Montevideo, and in Brazil.

Mr. Nodot divides the genera of loricate Edentates into the *Carnivorous* and *Herbivorous*. The former including *Euphractus*, *Chlamyphorus*, *Priodontes*, *Tatusia*, *Dasypus*, *Xenurus;* the latter, *Tolypeutes*, *Euryodon*, *Heterodon*, *Chlamydotherium*, *Schistopleurum*, *Glyptodon*, *Hoplophorus*, *Pachytherium* (?). All but *Tolypeutes* of the herbivorous are extinct species. The two series are nearly parallel to one another. In the proposed classification, an oblong ellipse is drawn; *Euphractus*, and *Chlamydotherium*, as the types of the two divisions, are placed at the foci; and then the genera of the carnivorous at intervals in the periphery to the left, the herbivorous in the same to the right, the representative genera of the two being arranged on the same transverse line. Moreover, besides Euphractus and Chlamydotherium on the middle or diametral line, Orycteropus, an aberrant carnivorous form, is placed at the upper extremity, and Pachytherium at the other. Our readers are referred to the Memoir for full explanations of the author's views.

22. *Etudes sur le Metamorphisme;* par M. DELESSE, Ingenieur des Mines. 300 pp., 8vo. From the Annales des Mines, [5], xii, 89, and 417.—To be completed in a following number of the Annales des Mines.

—Mr. Delesse has confined his observations, in the work here cited, to the metamorphism or alteration produced at the contact of an igneous rock with another it traverses, regarding this subject, correctly, as a proper introduction to that of metamorphism in general. He divides his work into *first*, the metamorphism of the *encasing* rock; and *second*, the metamorphism of the *eruptive* rock. The different kinds of eruptive and encasing rocks are reviewed in order, and afterwards the various examples of alteration which have been observed in connection with each, either by Mr. Delesse or other geologists, are carefully described. The locality and condition of the rocks are described, the normal or unaltered state, and then the altered state, taking into the consideration the specific gravity, the proportion of water and carbonic acid, and the mineralogical and chemical composition. As preparatory to the whole, the effects of the simple action of heat on the various rocks are dwelt upon at some length.

The plan of the work is thus comprehensive and complete. The 300 pages thus far published treat only of changes in the *encasing* rocks, where the eruptive rock is (1.) *Lava*, and (2.) *Trappean rock*. The part relating to cases where the vein is *granitic* is yet to be published. The discussion is preparing the way for the right consideration of the metamorphism of rock strata; and we shall look with interest for the future writings of Mr. Delesse on this subject.

The main difficulty in carrying out the separation between metamorphism connected with eruptive rocks and metamorphism not so connected, arises from the uncertainty of the line dividing off the two groups of altered and eruptive rocks from one another. Granitic veins are generally regarded as eruptive in all cases; and yet there is no evidence that in very many cases not only granite rocks (granite, syenite, &c.) may be metamorphic, but even granitic veins may be only an incident connected with metamorphism—a result of the opening of fissures deep down towards the interior heat, where heat and water brought in material from either side to fill the cavity, instead of an opening quite through to a source of liquid rock: for the characters of mineral veins prove the fact that such non-eruptive granitic veins have been made. Or the seeming vein may be only a metamorphosed sedimentary layer that once alternated with other sediments which now make the encasing rock—which through upturning or folding and displacement by disturbance and semi-fusion, have been thrown into vein-like forms. How then, in such doubtful cases, shall the line be drawn between the effects adjoining eruptive veins and those adjoining the non-eruptive? We look for light on these points in the following part of the work. The subject is illustrated by three folded plates full of figures and sketches, representing sections, veins, rock structures, and other particulars connected with metamorphism.

23. *Paléontologie de l'Ile de Sardaigne;* par le Professeur Ch. J. Meneghini, ou Description des Fossiles recueillis dans cette Contrée par le Général Albert de la Marmora. 586 pp., 4to, with eight large folded plates. Turin (Imprimerie Royale), 1857.—Professor Meneghini, the author of this great work on the Palæontology of the island of Sardinia, is one of the able corps of professors at Pisa, the author of works both on minerals, fossils, and some departments of zoology. The present work treats of all the Sardinian formations from the Silurian to the Pleistocene.

In the oldest fossiliferous strata only an imperfect cast of an Orthis was observed, and the precise age is undetermined. The next in the series contains species of *Tentaculites*, *Ptilodictya*, *Stictopora*, *Favosites*, etc. The next, *Murchisonia* near *M. carinata* of Hall, *Spirifer Terebratuliformis*, M'Coy, *Orthis elegantula*, *O. testudinaria*, *O. Patera*, Salter, *Ptilodictya lanceolata*, Lonsdale, etc. Over a dozen species of Graptolites are described from a succeeding stratum. In another above there are fifteen species of Orthoceras, several of them new, among them *Orthoceras Bohemicum* of Barrande. From this rock, there is a transition to the Carboniferous strata. The coal plants described are species of *Sigillaria*, *Cordaites*, *Odontopteris*, *Cyatheites* (11 species), *Alethopteris*, *Pecopteris*, *Oligocarpia*, *Calamites*, *Asterophyllites*, *Annularia*, *Sphenophyllum*, etc. The Jurassic, Cretaceous, Eocene and later Tertiary are well represented by organic remains.

24. *Manual of the Mineralogy of Great Britain and Ireland;* by Robert Philips Greg, F.G.S., and William G. Lettsom. 484 pages, 8vo, with 400 wood-cuts.—Great Britain is especially rich in ores and other minerals, and hence a treatise on British mineralogy has an interest far beyond that of most local works. The number of species described in this volume by Messrs. Greg and Lettsom is about 240. The authors appear to have elaborated the subject with care, both as to crystalline forms, and localities, and have introduced much information of economical interest. Mr. Greg has one of the best private collections of minerals in Great Britain; besides which, the authors have had access to various other cabinets. The chemical portions of the work were revised by Dr. Heddle of Edinburgh.

25. *The Geologist: a popular Monthly Magazine of Geology;* edited by S. J. Mackie, F.G.S., F.S.A. Vol. I, commencing with January, 1858. Each number 48 pages, 8vo. London. 1*s.* per number.—This new Journal, while popular in its aim and tone, contains papers of scientific value.

26. *Mastodon on Long Island.*—Teeth and other bones of a Mastodon have been recently dug up near Jamaica, Long Island, at Beaseley's Pond, where an excavation for a water reservoir for the city of Brooklyn is in progress.

27. *Mineralogical Notes;* by W. J. Taylor.—Examining a collection of minerals from Chili, I find a specimen of *Bieberite* or cobalt vitriol, a species not hitherto reported from that region. It is from Tres Puntos near Copiapo.

A *native anhydrous sulphate of ammonia* occurs at the Pacific guano islands (Chincha). It is in rather hard lumps about the size of hickory nuts, and has a very fine crystalline structure, a yellowish white color, bitter taste and pungent odor.

Heteromorphite occurs at Chonta, Peru, associated with pyrites and quartz. In the specimen, in which I have detected it, it is mostly in the form of "cob-webs;" some crystals are a sixteenth of an inch long. The specimens were labelled "antimonial silver."

Enargite has been distinguished by Mr. Taylor among minerals from New Granada, and he has published on the subject in the Proceedings Acad. Nat. Sci. Philad. 1857, 168. We defer a further notice till our next Supplement.

III. BOTANY AND ZOOLOGY.

1. *Illustrations of the Genus Carex;* by FRANCIS BOOTT, M.D., Treasurer and Vice President of the Linnæan Society. London, W. Pamplin, 1858: folio.—This vast genus has been a favorite study with American botanists ever since, almost forty years ago, the venerable Professor Dewey commenced the publication in this Journal of his extended *Caricography*, and Schweinitz, the preparation of the *Monograph of N. American Carices*, which, edited and extended by Dr. Torrey, made its appearance in the year 1824. Dr. Boott, whom we claim as one of *our* botanists, notwithstanding his long residence in London, has sedulously investigated this genus for twenty years, beginning with the British American species, which he elaborated for Sir Wm. Hooker's *Flora Boreali-Americana*. The imposing volume before us, with 200 folio plates, comprises a portion only of the results of his continued study of Carex, and forms what we presume may be regarded as only the first part of an illustrated monograph of the genus, which for the number, fullness and faithfulness of the figures, and the magnificent scale of the work, is altogether unrivalled. For, although this volume holds out no intimation of a successor, neither the materials nor the patience of the disinterested author are exhausted, and illustrations for a second volume as large as the first, are, as we believe, nearly ready for the engraver.

One reason for the predilection for our North American species which this volume indicates, and which renders the work so invaluable to the botanists of this country, is given in the brief preface, or rather letter which follows the dedication of the volume to the author's early friend John Amory Lowell, Esq., of Boston; in which he writes:

"My original design in this work was limited to the illustration of the *Carices* of North America, which I had studied for several years under the advantage of frequent communication with my friend Mr. Carey, who had so ably described and grouped them in Dr. Gray's *Manual of the Botany of the Northern States;* and the lithographed impressions were made in the prosecution of that design. The extensive and beautiful collection of specimens subsequently brought by Dr. Hooker from the East Indies, which were liberally placed in my hands by that eminent man, impelled me to extend my plan; and I have endeavored to illustrate the genus at large."

Accordingly most of the species here figured, are North American or East Indian. It will be useful to enumerate the North American Carices here illustrated. They are:

C. filifolia, Nutt.
comosa, Boott,
utriculata, Boott,
Tuckermani, Boott,
Olneyi, (n. sp.) Boott,
Baltzellii, Chapm.
Boottiana, Benth.
marcida, Boott,
Hoodii, Boott,
exilis, Dewey,
C. amplifolia, Boott,
crinita, Lam.
gynandra, Schw. (*C. crinita*, var. Schw. & Torr.)
Houghtonii, Torr.
siccata, Dewey,
Liddoni, Boott,
arida, Schw. & Torr.
decomposita, Muhl.
Torreyi, Tuckerm.

C. alveata, Boott,
polymorpha, Muhl.
dasycarpa, Muhl.
aristata, R. Br. (*C. mirata*, Dewey).
tenax, Chapm.
pubescens, Muhl.
oligosperma, Michx.
Raeana, Boott.
Crus-corvi, Shuttlw.
festiva, Dewey,
alopecoidea, Tuckerm.
macrocephala, Willd.
Deweyana, Schw.
Parryana (incl. *Arctica*,) Dewey,
monile, Tuckerm.
virescens, Muhl.
trisperma, Dewey,
aurea, Nutt.
lenticularis, Michx.
longirostris, Torr.
Cherokeensis, Schw., (incl. *C. Christyana*, Boott),
flexilis, Rudge,
Crawei, Dewey,
conoidea, Schk.
Meadii, Dewey,
tetanica, Schk.
granularis, Muhl.
grisea, Wahl.
flaccosperma, Dewey,
laxiflora, Lam. & vars., (*C. anceps*, *C. blanda*, &c.).
plantaginea, Lam.
Careyana, Torr.
platyphylla, Carey,
retrocurva, Dewey,
digitalis, Willd.
oligocarpa, Schk.
Hitchcockiana, Dewey,
C. Willdenovii, Schk.
Steudelii, Kunth,
Backii, Boott,
Geyeri, Boott,
concinna, R. Br.
synchnocephala, Carey,
tenella, Schk.
triceps, Michx.
lanuginosa, Michx.
vestita, Willd.
filiformis, L.
Sullivantii, Boott,
venusta, Dewey,
arctata, Boott,
formosa, Dewey,
oxylepis, Torr.
Davisii, Torr.
æstivalis, Curtis,
gracillima, Schw.
sterilis, Willd.
stellulata, Good., var. *scirpoides*,
striata, Michx.
trichocarpa, Muhl.
intumescens, Rudge,
Grayi, Carey,
lupulina, Muhl.
lupiniformis, Sartwell,
gigantea, Rudge,
hystricina, Muhl.
torta, Boott,
decidua, Boott,
cryptocarpa, Meyer,
ambusta, Boott,
verticillata, Boott. [non Zoll. & Mor.]
Barrattii, Torr. (*C. flacca*, Carey, &c.),
ustulata, Wahl.
eburnea, Boott,
miliaris, Michx.

This ample list will be found to comprise a very large share of the Carices of Gray's Manual, as well as of the North American species of higher northern, more southern, and western regions. The view of these truthful figures brings back a lively remembrance of our former studies and collections of these fascinating plants, with no such volume as this to help us.

If, in questionable cases, our author is disposed rather to separate specifically than to combine, he has in this pursued the wiser and the more useful course, considering the nature of the present work, in which the main object is to give accurate representations of all the known Carices.

So the absence of any classification of the species is no disparagement here, assuredly expecting, however, that in due time, Dr. Boott will propound his matured views respecting the natural arrangement of the genus *Carex*. A. G.

2. *Journal of the Proceedings of the Linnæan Society, Botany*, Vol. II, No. 7, (1858).—Professor Henslow contributes a brief but interesting paper, On a Monstrous development in *Habenaria chlorantha*, which is thought to elucidate the morphology of the androecium.

Dr. A. Gray has an article, On the structure of the ovule and seed-coats of *Magnolia*,—illustrated by wood-cuts; which represent the growth of the ovule, its structure at the time of flowering, and the subsequent changes through which the primitive or outer coat of the ovule becomes *drupaceous* in the seed, its principal thickness thus forming the fleshy coat, while a growth of its inner stratum gives rise to the bony coat of the seed. This was briefly shown in Hooker's Journal of Botany for 1855–6. The results of new observations are here detailed, and illustrated by truthful sketches. The observations which this paper simply records have recently been again disputed by Mr. Miers (in Ann. and Mag. Nat. Hist., for April last), who undertakes to demonstrate *a priori* that they cannot possibly represent the true state of the case. It suffices to reply: first, in the language of a distinguished investigator, that, leaving philosophers to determine what is and what is not possible, the business of the naturalist is to ascertain what is real; and that which is really so will always be possible, in spite of all contradiction. And, secondly, that the argument in this case, after all, is *not* "as convincing as any demonstration in Euclid;" because the six formal premises (i. e., whatever in them bears directly upon the point), from which the four inferences (called "axioms") were deduced, are not conceded. We refer particularly to the sixth premise, upon which the whole question turns; its statements appear not to accord with the obvious facts of the case in the anatropal ovule.

The remaining articles are:—Notes of a Botanical Ramble in the North of Spain, by Joseph Wood, Esq. Note on the Genus *Hemigymnia* of Griffith, by Dr. Thomas Thomson; showing that what Griffith took for a new Verbenaceous type is merely a *Cordia*. Note on some Suprasoriferous Ferns, by Thomas Moore, Esq., especially in a Fern with normally margined fructification allied to *Deparia*. Description of a remarkable spike or bunch of fruits of the Fig-Banana, producing two forms of fruit from the same inflorescence. On four Varieties of British Plants, by John Hogg, Esq.; and a part of Dr. F. Müller's Botanical Report on the North-Australian Expedition under the command of Mr. Gregory.

Thankful for what we have, we could still wish that the resources of the Linnæan Society were such as to enable it to publish more than it does, especially of rather extensive papers upon systematic botany, such, for instance, as Bentham's *Loganiaceæ*, and Hooker and Thomson's *Præcursores* of the Indian Flora. A. G.

3. *A list of the Orchidaceous Plants collected in the East of Cuba, by Mr. C. Wright, with Characters of the New Species*, by Prof. LINDLEY, (from *Ann. and Mag. Nat. Hist.*, May, 1838).—It appears that of the 80 species of Orchids gathered by Mr. Wright in his recent visit to Cuba, 21 are novelties (here characterized by Prof. Lindley), and several others

have scarcely been seen since the time of Swartz;—showing "how rich in new species of the Order is the vegetation of that little-known island, and how much is still open to discovery by the diligent traveller." A. G.

4. *Salices Boreali-Americanæ: a Synopsis of North American Willows;* by N. J. ANDERSSON, Professor of Botany in the University of Stockholm, Sweden.—In the March number of the Journal we stated that Prof. Andersson had undertaken to elaborate the *Salicineæ* for De-Candolle's Prodromus, and that materials in the form of compiete specimens of Willows were earnestly solicited from every part of this country, in order that he may attain to something like the same full acquaintance with our species which he possesses of the European forms. We are happy to announce that Prof. Andersson has already made a preliminary study of our Willows, from such materials as he has been able thus far to examine; and that he has embodied the results in a memoir upon the subject, which is just printed in the Proceedings of the American Academy of Arts and Sciences, vol. iv, where it occupies thirty-two pages. The introduction and the conclusion, embracing a critical comparison of our Salices with those of Europe, are written by Professor Andersson in the English language (which he uses with remarkable facility); the descriptive and critical matter is in Latin. To render it accessible to all who take an interest in the subject, a small separate edition has been printed, and is sold by Messrs. B. Westermann & Co., No. 290 Broadway, New York. On the receipt by the Messrs. Westermann, or by the writer of this notice, of postage stamps to the amount of 36 cents, a copy will be sent by mail, prepaid, to any applicant. A. G.

5. *Systematische Untersuchungen über die Vegetation der Karaiben, in besondere der Insel Guadeloupe;* von A. GRISEBACH, (from Trans. Roy. Soc. Sci. Göttingen, vol. xvii, 1857), pp. 138, 4to.—This sketch of the Flora of Guadaloupe is very interesting and useful in itself, and of good promise for the *Flora of the British West Indies*, upon which Prof. Grisebach is now engaged, and which is so greatly needed. A. G.

6. *Essai d'une Exposition Systématique de la Famille des Characées;* par feu J. WALLMAN. *Traduit du Suedois;* par M. le Dr. W. NYLANDER. Bordeaux, 1856, pp. 91, 8vo.—This monograph of the *Characeæ* appeared in the Transactions of the Royal Academy of Sciences of Stockholm for 1852, published in 1854, a year after the death of the author, who barely lived to complete the manuscript. To render the mongraph more generally accessible, M. Durien de Maisonneuve engaged Dr. Nylander, the lichenologist, a compatriot of the author, to translate the memoir from Swedish into French, and caused it to be reproduced in this form in the Transactions of the Linnæan Society of Bordeaux, in the first volume of the third series, 1856, also publishing a small extra impression in a pamphlet form. The author characterizes no less than fifty species of *Nitella*, and sixty-six of *Chara*. A. G.

7. *Elogio di Filippo Barker Webb, scritto da* FILIPPO PARLATORE. Firenze, 1856, 4to, pp. 113.—The late Mr. Webb, a celebrated English botanist long resident in Paris, bequeathed his vast herbarium and excellent library to the Grand Duke of Tuscany, along with some funds for the care and augmentation of the collection. The immediate charge of collection was of course entrusted to Prof. Parlatore, a near friend of the

testator, and a most zealous botanist. After coming into possession of this noble bequest, upon the occasion of opening his course of lectures for the year 1855, Professor Parlatore pronounced the eulogy here published. It is illustrated by interesting explanatory notes, and followed by a catalogue of the works and opuscula published by Mr. Webb, twenty-four in number; by an account of his library and herbaria; and by selections from his correspondence with various botanists. The lithographed portrait in the frontispiece is a truer likeness of Mr. Webb than that which was published in his great work, the *Histoire Naturelle des Iles Canaries.* A. G.

8. *Agricultural Botany in the Western States.*—In the fourth volume of the Transactions of the State Agricultural Society of Wisconsin for 1854–7, Mr. Lapham has given a good popular account of the forest trees indigenous to that State, illustrated by outline wood-cuts. To the Transactions of the Illinois Agricultural Society for 1856–7 the same indefatigable author has contributed, 1. A Catalogue of the Plants of Illinois, prefaced by some historical and statistical details; 2. An account of the Native, Naturalized and Cultivated Grasses of Illinois, illustrated by three plates or pages of wood cuts. These do not equal the figures in Mr. Lapham's Grasses of Wisconsin. We are disposed to doubt the statement on p. 559 about the difference in the specific gravity of the pollen of Indian corn and of wild rice, unless the author can vouch for it from his own proper observations. Perhaps it rests upon no better basis of fact than the statement on the preceding page, that "had the wheat crop been at any time entirely destroyed, this invaluable grain would have been restored to us from seeds preserved for more than three thousand years in the folds of an Egyptian mummy!" We ought perhaps to say, that the asserted cases of such germination will not bear examination; and that those best qualified to judge utterly disbelieve, not only the asserted fact, but also the possibility of any such occurrence. A. G.

9. *How Plants Grow: A simple Introduction to Structural Botany; with a Popular Flora, or an arrangement and description of Common Plants, both wild and cultivated;* by Asa Gray, M.D., Fisher Professor of Natural History in Harvard University. 234 pp., 16mo, illustrated by 500 wood engravings. New York, 1858. Ivison & Phinney.—Dr. Gray has prepared this little volume expressly for young beginners in botany, and for use in common schools, and has well carried out his purpose. The work is simple in style, and beautiful in its illustrations. While teaching with clearness the details of the subject, it is constantly bearing the mind, by simple explanations, above these details to higher thoughts and principles, and preparing it for the fuller survey of the science in the more extended works of the author's series. He considers in order —1st, How plants grow, and what their parts or organs are; 2d, How plants are propagated or multiplied in number; 3d, Why plants grow; what they are made for and what they do; 4th, How plants are classified, named and studied. Then, in the second part, the work contains a "Popular Flora for Beginners," including descriptions of the common plants of the country, both those of the woods and fields, as well as those of our yards and gardens. It is arranged according to the natural sys-

tem, and for the beginner in the science takes the place of the large Manual of Botany. The excellence of the volume consists in its being really "science made easy"—not by culling out "interesting facts" to attract, and tying them artfully together, but by presenting the *system of fundamental truths* in a manner intelligible and attractive to the young mind.

10. *The animals of Millepora are Hydroid Acalephs and not Polyps;* by Prof. AGASSIZ, (from recent letters to J. D. DANA).—"I have seen in the Tortugas something very unexpected. Millepora is not an Actinoid polyp, but a genuine Hydroid, closely allied to Hydractinia. This seems to carry the whole group of Favositidæ over to the Acalephs, and displays a beautiful array of this class from the Silurian to this day."

The drawings of Professor Agassiz which have been sent us for examination, are so obviously Hydractiniæ in most of their characters that no one can question the relation. With regard to the reference of *all* the Favositidæ (a group including Favosites, Favistella, Pocillopora, etc., as well as the minuter Millepora, Chætetes, etc.) to the Acaleph class, direct evidence is not yet complete, as the animal of the Pocillopora has not been figured by any author on zoophytes.* On this point Professor Agassiz observes in a subsequent letter, after observing that the Sideroporæ obviously are polyps:

"There are two types of radiating lamellæ, which are not homologous. In true Polyps (excluding Favositidæ as Hydroids), the lamellæ extend from the outer body wall inward, along the whole height of that wall, and the transverse partitions reach only from one lamella to the other, so that there is no continuity between them, while the radiating lamellæ are continuous from top to bottom in each cell. In Milleporidæ the partitions are transverse and continuous across the cells and so are they in Pocillopora and in all Tabulata and Rugosa, while the radiating lamellæ, where they exist, as in Pocillopora and many other Favositidæ, rise from these horizontal floors and do not extend through the transverse partitions; indeed they are limited within the spaces of two successive floors, or to the upper surface of the last. A careful comparison of the corallum of Millepora and Pocillopora with that of Hydractinia has satisfied me that these radiating partitions of the Favositidæ far from being productions of the body-wall are foot secretions, to be compared to the axis of the Gorgonia, Corallium, etc., and their seeming radiating lamellæ to the vertical grooves or keels upon the surface of the latter, which, reduced to a horizontal projection, would also make the impression of radiating lamellæ in the foot of the Polyp. If this be so, you see at once that the apparent radiating lamellæ of the Favositidæ do no longer indicate an affinity with the true Polyps, but simply a peculiar mode of growth of the corallum; and of these we have already several types, that of Actinoids, that of Halcyonoids, that of Bryozoa, that of Millepora and other

* From the specimens of the species of this genus which I procured in the Pacific I never obtained a clear view of the polyps, and hence made no figure. The brief description on page 523 of my Report, may be reasonably doubted until confirmed by new researches. The much larger size of the cells in Pocillopora, Favosites and Favistella than in Millepora, and the frequently distinct rays in these cells, are the characters I had mentioned to Prof. Agassiz as suggesting a doubt as to their being Acalephs, and to this what follows above relates.—J. D. D.

Corallines, to which we now add that of the Hydroids. Considering the subject in this light, is there any further objection to uniting all the Favositidæ with the Hydroids,—Sideropora and Alveopora being of course removed from the Favositidæ. It is a point of great importance in a geological point of view, and for years I have been anticipating some such result, as you may see by comparing my remarks in the Amer. Journal, May, 1854, p. 315. If all the Tabulata and Rugosa are Hydroids, as I believe them to be, the class of Acalephs is no longer an exception to the simultaneous appearance of all the types of Radiata in the lowest fossiliferous formations and the peculiar characters which these old Hydroid corals present appears in a new and very instructive aspect."

11. *Prodromus Descriptionis Animalium Evertebratorum, etc. Invertebrate species from the North Pacific;* by W. Stimpson. Parts III and IV. 16 pp., 8vo. From the Proceedings of the Academy of Natural Sciences, December, 1857, and March, 1858.—In this pamphlet, Mr. Stimpson notices in brief, the species of Maioid, Cancroid and Corystoid Crustacea obtained by him in his most fruitful North Pacific investigations. In all there are 136 species; of which, 18 of the species of Maioids, 32 of the Cancroids, and 1 of the Corystoids, are new. Among them, there are the following new genera: *Micropisa* and *Achæopsis* among Maioids, and *Lachnopodus*, *Sphærozius* and *Heteropanope* among Cancroids.

Part V has also appeared in the Proceedings Acad. Nat. Sci. Philad., 1858, p. 93—110. It takes up the Grapsoids and enumerates 108 species, of which 44 are described as new. The new genera instituted are: Family Carcinoplacidæ, *Pilumnoplax*, *Heteroplax;* Family Rhizopidæ, (related to *Gonoplacidæ*, but *eyes immoveable*, &c.), *Scalopidia*, *Rhizopa*, *Typhlocarcinus*, *Ceratoplax;* Fam. Macrophthalmidæ, *Chænostoma*, *Ilyoplax;* Fam. Dotillidæ, related to *Doto* of De Haan, which generic name is changed to *Dotilla* on the ground of its being preoccupied; Fam. Thelphusidæ, *Geothelphusa;* Fam. Grapsidæ, *Ptychognathus*, *Acmæopleura;* Fam. (new) Camptandridæ, *Camptandrum;*. Fam. Asthenognathidæ (new), *Asthenognathus;* Fam. Hymenosomidæ, *Rhynchoplax.*

12. *Icones Zootomicæ* mit Originalbeiträgen der Herren G. J. Allman, C. Gegenbaur, Th. H. Huxley, Alb. Kölliker, H. Müller, M. S. Schultze, C. Th. E. von Siebold und F. Stein, herausgegeben von Julius Victor Carus, Prof. der vergleichenden Anatomie in Leipzig. Erste Hälfte oder Tafel I–XXIII, *Die Wirbellosen Thiere.* Leipzig, 1857. Verlag von Wilhelm Engelmann,—The *Icones Zootomicæ* of Prof. Carus are representations of the various tribes of the Animal Kingdom as to their details of anatomical structure in a series of large folio plates. The author commences with the Protozoa (Gregarinæ, Ciliata or Infusoria, Rhizopoda); the Radiates follow in order, then the Articulates, and then the Molluscs. The second half of the work, including plates 24 to 44, and illustrating the Vertebrata, is promised to appear in the course of the year 1858. The plates are executed with care and beauty, and each is accompanied with a leaf of explanations. The work is well adapted for the student in zoology, and we could wish that the plates might be issued also with English text. The internal anatomy of the various groups is elabo-

rately represented, and the student has but to turn over from plate to plate to gain an insight into the whole range of animal organisms. In general the work gives the results of the most recent investigations. Its system of classification, however, has not met with favor among zoologists.

13. *General Report upon the Zoology of the several Pacific Railroad Routes.* Part I. *Mammals.* By SPENCER F. BAIRD. 1 vol. 4to. Washington, 1857. We cite the following notice of Prof. Baird's great work from the Annals and Mag. Nat. Hist., May, 1858.

"The contributions already made to our knowledge of the Fauna of North America by the zoological appendices to the Reports of various Surveys and Explorations ordered by the government of the United States, are neither few nor unimportant. The accounts of expeditions to the Red River of Louisiana, the Great Salt Lake of Utah, and the Zuñi and Colorado Rivers, all contain materials worthy of much attention, and especially calculated to throw light upon the theory of the distribution of animal life in the North American continent. And in the Reports of the recent U. S. Astronomical Survey in the southern hemisphere, and of Commodore Perry's Japan expedition, we have evidence that the American government is sufficiently 'catholic' in its promotion of scientific investigation not to refuse assistance in extending our knowledge of the zoology of other parts of the world besides those immediately subject to its sway.

The seventh volume of the 'Reports of Explorations and Surveys to ascertain the most practicable and economical route for a Railroad from the Mississippi to the Pacific Ocean, made under the direction of the Secretary of War in 1853–56,' the title of the first part of which is given above, promises to bring still greater additions to our knowledge of North American zoology than any of the previous publications. This first part embraces only the *Mammalia;* but if the Birds, Reptiles, Amphibians, Fishes, and other orders of organized beings, are treated of in the same way, the result will be a complete and very interesting *résumé* of the zoology of this portion of the globe. The numerous different surveying parties which were employed on the proposed Pacific railway routes, amassed a very large quantity of materials for scientific research, which were all transferred by the U. S. Government to the guardianship of the Smithsonian Institution at Washington. The energetic Assistant Secretary of that establishment, Professor Baird—than whom no one could be found better qualified for the task—has himself undertaken to work out the specimens of Mammalia collected. The same gentleman, together with Mr. Cassin, the well-known ornithologist, will take the Birds. The Reptiles will probably be assigned to Prof. Girard or Dr. Hallowell, and the other orders to the naturalists best qualified to deal with them. This is an excellent method—putting the "right man in the right place," instead of setting a man learned in one 'ology to work at another, according to a plan which we have before now seen adopted in this country.

The present volume, which is the first of the series, and is entirely from the pen of Professor Baird, gives a general account of all the species of Mammals collected by the various aforesaid expeditions, noticing at the same time, in their proper places, all those known to inhabit the continent

of North America. It contains the technical descriptions of the families, genera, and species, remarks necessary to show their places in the system, their synonymy, and "an enumeration of all the different specimens collected." Other volumes will be devoted to the zoology of the separate expeditions, and enter more into particulars concerning habits, manners, &c. We beg to call particular attention to the plan of stating the exact locality of every specimen collected, here adopted, which is most useful for working out the theory of geographical distribution,—a subject now attracting so much attention.

"The time is now passed," says a recent distinguished writer on natural history, "when the mere indication of the continent whence an animal had been obtained could satisfy our curiosity; and the naturalists who have an opportunity of ascertaining closely the particular circumstances under which the animals they describe are placed in their natural home, are guilty of a gross disregard to the interests of science when they neglect to relate them. Our knowledge of the geographical distribution of animals would be far more extensive and precise than it is now, but for this neglect; *every new fact relating to the geographical distribution of well-known species is as important to science as the discovery of a new species.*"

To this volume there are likewise attached indices of the particular localities mentioned, of the authorities referred to, of local names and of scientific names,—all most useful and valuable appendages to the work.

The total number of species of Mammalia now recognized by Professor Baird as inhabiting the North American continent amounts to 220, of which he has himself examined specimens, whilst there are 35 others more or less doubtful. This is a vast increase,—no less than 70 species having been added as new to Audubon and Bachman's list, the greater part being the result of these expeditions. This, too, is exclusive of *Cetacea*, *Pinnipedes*, and *Bats*, none of which are touched upon in the present treatise. The first two of these groups can hardly be said to belong to the land-fauna of North America; but we must allow something for the *Chiroptera*, to arrive at the true number of North American Mammalia. Major John Leconte in his paper in the seventh volume of the 'Proceedings of the Academy of Natural Sciences of Philadelphia,' which is, we believe, the only modern authority on North American Bats, mentions fifteen species only as recognized by himself. This, however, raises the number of positively recognized Mammalia belonging to the North American fauna to 235, excluding Pinnipeds and Cetaceans.

Taking the several groups in the order in which they stand in Professor Baird's arrangement, we have first the *Insectivora*, containing Shrews and Moles,—together 26 species. Among these is a very remarkable (if reliable) addition to the American fauna in the shape of a second species of *Urotrichus*, a genus of *Talpidæ* hitherto embracing but one member, found in Japan. We may, however, notice the fact that but one imperfect specimen of this animal appears as yet to have been obtained; and an accurate comparison of it with the Japanese *Urotrichus* is requisite, before animals coming from localities so different can be recognized without doubt as the two only members of the same peculiar genus.

Of the *Carnivora* the large number of 46 are recognized as North American, made up of 9 *Felidæ*, 8 *Canidæ*, the *Bassaris astuta* of Mex-

ico and Texas—sole representative of the family *Viverridæ*, 23 *Mustelidæ*, and 5 species of *Ursidæ*. This is exclusive of several species established by previous writers, but which Prof. Baird has, with much judgment, reduced to the rank of local varieties—such as the *Canis nubilus* of Say, and the *Felis maculata* of Horsfield and Vigors.

The *Marsupialia* in the northern portion of the American continent are represented by two species of the genus *Didelphis*, commonly known as 'Opossums.'

The Rodents are, again, extremely numerous. In the first place, the Squirrels of different genera, with the Marmots (so called), Prairie-dogs, and Beavers, make up no less than 41 members of the family *Sciuridæ*. The *Saccomyidæ*, or Pouched Mice, which, in accordance with Mr. Waterhouse's views, but in opposition to those of Professor Brandt, are grouped together, next follow, and are considered by Professor Baird as "one of the most natural families of Rodentia, although the component genera have been widely separated by different authors. In the external cheek-pouches," he remarks, "there is no other family which exhibits any approach to it. These open outside of the mouth, and are of variable depth and lined with short hairs to the bottom. When inverted and dried, they look like sacs on each side of the head." Of these peculiar animals, the range of which is confined to Northern America and the Antilles, 21 species are enumerated, as appertinent to the fauna of the United States. Two Porcupines of the North American form *Erethizon* are the only *Hystricidæ* met with in this part of the world; but there are no less than 52 *Muridæ* of varied forms; and 13 Hares and Rabbits, with a single *Lagomys*, give 14 species of the family *Leporidæ*. Altogether, therefore, the order Rodentia in North America, as elsewhere, plays a most important part as regards numbers, embracing 130 species—more than half the whole number of Mammals known to occur.

The order *Edentata* is represented within the limits of the United States by a single straggling species of Armadillo, which occurs within the confines of Texas, and is somewhat doubtfully referred to the *Dasypus novem-cinctus* of Linnæus.

The Pachyderms have also but a single representative, the Collared Peccary, *Dicotyles torquatus*, which, it is remarked, "has a much wider range in North America than is supposed by European systematic writers. It not only occurs through Mexico, but even as far north in the United States as the Red River of Arkansas, in latitude 34°."

The Ruminants, however, muster more strongly, being better adapted for residence in the temperate regions of the North. In the first place, we have the Moose, *Alce Americana*. Then two species of Reindeer are admitted under the titles *Rangifer Caribou* and *R. Grœnlandicus*, though it is allowed that their distinctness is questionable. It is highly desirable that accurate investigations should be made as to the difference of these animals *inter se*, and with the European *R. Tarandus*, which is said to present somewhat corresponding variations. The genus *Cervus* and its subdivisions are represented by no less than six species, which are said to be all truly different, although the distinctions between *Cervus Virginianus* and *C. leucurus*, and *C. macrotus* and *C. Columbianus* require some further elucidation. North America contains only two Antelopes, the 'Prong-horn' (*Antilocapra Americana*), and the so-called 'Mountain-goat'

(*Haplocerus montanus*), and a single sheep, the well-known Big-horn of the Rocky Mountains, *Ovis montana*. The Musk-ox of the Arctic regions (which, however, does not occur within the limits of the United States), and the Buffalo, *Bison Americanus*, conclude the catalogue of North American Ruminants, making up a total of 14 animals of this order. What a contrast in this respect does North America present to Africa, where more than 60 species of Antelopes alone are already known to occur, and the list is daily increasing! For, though we may laugh at Buffon's theory as to the animals of America being merely degraded forms of those of the Old World, there can be no question that the 'Great Continent' is far more productive of animal forms of a more highly organized structure, and of a nature more adapted to meet the various wants of mankind.

Table of Genera of North American Mammalia, according to Prof. Baird.

[The first column of figures gives the number of species examined by Prof. Baird himself, and the second, in brackets, those he has not examined.]

	Species.	
I. Rapacia.		
1. Soricidæ—		
1. Neosorex,	1	
2. Sorex,	12	[4]
3. Blarina,	7	
2. Talpidæ—		
4. Scalops,	4	[1]
5. Condylura,	1	
6. Urotrichus,	1	
3. Felidæ—		
7. Felis,	5	
8. Lynx,	4	
4. Canidæ—		
9. Canis,	2	
10. Vulpes,	6	
5. Viverridæ—		
11. Bassaris,	1	
6. Mustelidæ—		
12. Mustela,	2	
13. Putorius,	10	[1]
14. Gulo,	1	
15. Lutra,	2	
16. Enhydra,	1	
17. Mephitis,	5	[1]
18. Taxidea,	2	
7. Ursidæ—		
19. Procyon,	2	[1]
20. Ursus,	3	
II. Marsupiata.		
8. Didelphidæ—		
21. Didelphis,	2	
III. Rodentia.		
9. Sciuridæ—		
22. Sciurus,	12	[6]
23. Pteromys,	4	
24. Tamias,	4	
25. Spermophilus,	14	[1]
26. Cynomys,	2	
27. Arctomys,	2	[2]
28. Aplodontia,	1	
29. Castor,	1	
30. Castoroides,	1	
10. Saccomyidæ—		
31. Geomys,	5	
32. Thomomys,	7	[1]
33. Dipodomys,	3	[2]
34. Perognathus,	6	
11. Muridæ—		
35. Jaculus,	1	
36. Mus,	4	
37. Reithrodon,	4	[1]
38. Hesperomys,	15	[1]
39. Neotoma,	6	
40. Sigmodon,	2	
41. Arvicula,	16	[11]
42. Myodes,	3	
43. Fiber,	1	
12. Hystricidæ—		
44. Erethizon,	2	
13. Leporidæ—		
45. Lepus,	13	[2]
46. Lagomys,	1	
IV. Edentata.		
14. Effodientia—		
47. Dasypus,	1	
V. Pachydermata.		
15. Suidæ—		
48. Dicotyles,	1	
VI. Ruminantia.		
16. Cervidæ—		
49. Alce,	1	
50. Rangifer,	2	
51. Cervus,	6	
17. Cavicornia—		
52. Antilocapra,	1	
53. Aplocerus,	1	
54. Ovis,	1	
55. Ovibos,	1	
56. Bos,	1	
	220	[35]."

14. *On Species.*—In the article on Species, by J. D. DANA, in the number of this Journal for November last, (vol. xxiv,) there are the following typographical errors.—On page 313, 13th line from top, *equalities* should be *qualities;* and on the following page, 21st line from bottom, *propositions* should be *proportions.*

IV. ASTRONOMY.

1. *Fifty-Third Asteroid.*—This planet was discovered April 4, 1858, by Dr. Luther, at Bilk, and has been named *Calypso.* The fifty-second asteroid is called *Europa.*

2. *Third Comet of* 1858, (Gould's Astron. Journal, No. 113.)—The third comet of 1858 was discovered, May 2, 1858, by Mr. Horace Tuttle of the Harvard College Observatory, Cambridge, Mass.

3. *New Determination of the Solar Parallax,* (in a letter from Lieut. J. M. GILLISS to the Secretary of the Navy, dated Washington, Feb. 18, 1858.)—I have the honor to communicate to you the results of the observations specially made by the United States Naval Astronomical Expedition to determine the solar parallax—the sun's distance from the earth.

It will be remembered by the Department that Dr. Gerling—an eminent geometer of Germany—suggested the practicability of determining this fundamental astronomical datum from observations of Venus near the inferior conjunction, instead of awaiting the rare phenomenon of transits of the planet across the sun's disc; that an expedition to the southern hemisphere was proposed to the Department by myself for the purpose of making these observations, which, in connection with similar observations to be made at the Naval Observatory, would test the method; and that the earnest commendation of the measure by physicists, both in Europe and this country, induced Congress to authorize the expedition by special grants in the appropriation bills approved in 1848 and 1849.

We were absent from the United States nearly three and a half years, and the observations, constituting the more immediate object of the expedition, extended through parts of each of the years from November, 1849, to September, 1852, inclusive. So many classes of observations were embraced in the plan of operations adopted by the Department, that our small party was almost constantly occupied in observatory duty proper, and it was not possible to prepare any of the data for the final computations until after the return of the expedition to the United States. Then our first efforts were to put in proper form for the computer all the observations of the planets Venus and Mars, and the stars with which they had been compared. Whilst our men of science had been unanimous in advocating the organization of an expedition, because of the additional mass of important information certain to be collected by it, there were some who entertained an opinion that the method of determining the parallax proposed by Dr. Gerling would not afford a result as reliable as had been derived from the transits of Venus in 1761 and 1769. For obvious reasons, therefore, it was proper that the discussion of the results from our observations should be intrusted to an astronomer thoroughly competent to appreciate the problem, yet wholly uncommitted as to the comparative merits of the two methods.

Under the sanction of the Department, Dr. B. A. Gould, Jr., of Cambridge, Mass., was selected for the purpose; and the elaborate refinement

with which he has executed this difficult and delicate task, is ample evidence that the confidence of the Department was not misplaced. His report does him great honor. It will fill from 130 to 140 pages of volume third of the results of the expedition, the larger portion of it, and all the remainder of the volume, being already printed.

The result obtained by him for the Sun's Equatorial Horizontal Parallax is 8″·4950, or 0″·0762 less than the value commonly adopted, and he concludes that we may assume with advantage 8″·5000, corresponding to a distance from that luminary of 96,160,000 statute miles. As the information is of high interest to astronomers, I have the honor to suggest that it be made known in advance of the publication of the volume.

4. *Theory of the Motion of the Heavenly Bodies moving about the Sun in Conic Sections: a translation of Gauss's "Theoria Motus," with an Appendix;* by CHARLES HENRY DAVIS, Commander, United States Navy, Superintendent of the American Ephemeris and Nautical Almanac. Boston: Little, Brown & Co. 1857.—It appears from the translator's preface to this work that it is to the liberality of the Smithsonian Institution and the Navy Department, that we owe the first appearance of Gauss's immortal work in an English dress. By the authority of the Hon. J. C. Dobbin, Secretary of the Navy, the translation of Commander Davis has been printed by the joint contributions of the Nautical Almanac and the Smithsonian Institutions.

Although it must be a long time before Gauss's profound work can be superseded, yet since its publication in 1809, some improvements (not indeed very important) have been made, and certain parts of the method have received special development. To bring the work fully up to the time, therefore, Commander Davis has added an Appendix containing the results of the investigations of Professor Encke and Professor Peirce upon the exceptional case of a twofold determination of the orbit from the same three geocentric places; Prof. Peirce's Graphic Delineations, showing geometrically the roots of Gauss's Equation IV Article 141; a Table for the Motion in a Parabola from LeVerrier's *Annales de l'Observatoire Imperial de Paris;* Bessel's and Posselt's Tables for Ellipses and Hyperbolas closely resembling the Parabola; a convenient Table by Professor Hubbard for facilitating the use of Gauss's formulas for ellipses and hyperbolas, of which the excentricities are nearly equal to unity; and, in the form of notes on their appropriate articles, useful formulas by Bessel, Nicolai, Encke, Gauss and Peirce.

As to the subject matter, therefore, this publication leaves scarcely anything to be desired, and must prove a highly acceptable aid to the student of theoretical astronomy as well as to the practised computer.

The typographical execution of the work is also worthy of the classic original. We are also insured the greatest accuracy in the *formulas* of the body of the work by the careful supervision of Prof. Chauvenet, who (judging by the list published in the Astronomical Journal, No. 109) has probably left no erratum of the slightest importance uncorrected.

We wish we could speak as unreservedly in praise of Commander Davis's translation of the text. It is true that, with some exceptions, which we shall be compelled to notice presently, he has contrived to convey Gauss's meaning by a *verbatim* translation, which has at least the

merit of being very faithful and of taking no liberties with the original. Something more, however, was to be expected from a translator of Gauss. A faithful and indeed a literal translation need not be ungainly and stilted; certainly it can and should be purged of Latinisms. We are not obliged to write, "it is also, evidently, *allowable* to bring the same expression under the form," etc.,* simply because we happen to have in the original the words "reducere *licet*." Nor is the Latin word "petitur" in the sentence "Methodus alia, problema art. praec. solvendi, ex aequationibus $\cos\varepsilon \sin l =$ &c., *petitur*;" gracefully or even correctly rendered by "is required" in the sentence "Another method *is required* of solving the problem of the preceding article from the equations $\cos\varepsilon \sin l =$ &c."† In Art. 70 Gauss says: "Sponte jam patet, omnes aequationes Art. 62 etiam hic locum esse habituras;" the translator says, "Now it is evident that all the equations of article 62 will be applicable to this place also;" a rendering that suggests the impossible idea that the translator thought *hic* and *locum* to agree in case!

These instances are, however, of very little importance, since an intelligent reader can perceive what was intended. But it is far different when the translation becomes unintelligible without a reference to the original. Thus we find in Art. 115, "But although, *from an indiscernible principle*, it is not to be expected that such a case" (the special case in which the plane of the orbit coincides with the ecliptic) "would ever actually present itself in nature," etc. Upon reading which we were seized with a strong desire to know what "an indiscernible principle" could be; but as the translation gave no clue, we turned to the original, where we were amazed to find the sentence to read thus: "Etiamsi vero *per principium indiscernibilium* haud exspectandum sit, talem casum in rerum natura umquam se oblaturum esse," etc. Can it be believed that a translator of Gauss should, even in a moment of forgetfulness or carelessness, imagine that the neuter genitive plural *indiscernibilium* agrees in case and number with the neuter accusative singular *principium*? And yet, how can we escape this conclusion, since it is evident that he has at last given up in despair of finding out what Gauss meant, and has written down what he thought was at least a *safe literal* translation! It is hardly necessary to tell the reader who has referred to the original, that in the phrase "by the principle of indiscriminate (things)," Gauss briefly sums up the argument that since the orbits fall in all positions *indiscriminately*, any one special position in an assumed plane, was not to be regarded as probable. We should have been well satisfied with the fidelity of the translator, if, instead of "by an indiscernible principle," he had given the (unavoidably) free translation, "from the fact that the orbits may fall in all positions indiscriminately."

We have marked a number of mistranslations (such at least in our judgment) quite as glaring as the above. We shall only stop to notice the following. In Art. 78, "fiet generaliter" is rendered "it may generally be done," when the meaning is certainly "it may be done in a general manner" (*always*). In Art. 81, "postquam angulus auxiliaris A per aequationem tang $(A$—etc.) determinatus est," is translated "afterwards the auxiliary angle A is determined by the equation tan $(A$—etc.);"

* Art. 58. † Art. 67.

when the meaning is, "after the angle A has been determined by, &c.;" as the translator would have known, even in his ignorance of Latin, if he had only understood the mathematics of the subject matter.

In Art. 88, we have, "Let the eccentric anomalies E, E', and the radii vectores r, r', correspond to two places of the true anomaly v, v', (of which v is first in time); the Latin being, "Respondeant duobis locis anomaliae verae v, v' (e quibus v sit tempore anterior), anomaliae excentricae E, E', radiique vectores r, r';" where it appears again that the translator forgot to consult his Latin grammar. He would have found that *anomaliae* here cannot be the genitive singular; but aside from this, there is no sense in the expression "two places of the true *anomaly* v, v'." It is clear, in short, that *anomaliae verae*, *anomaliae excentricae* and *radii vectores* are all in the same case, subjects of *respondeant*.

In Art. 98, there occurs in the original "*Pro p* enim adhiberi poterit vel aequatio 7 art. praesentis, vel aequ. 18, art. 95:" which, the slightest acquaintance with the equations referred to would have enabled the translator to see, means "*For p* (that is, for computing p) we may employ either equation 7 of the present article, or equation 18 Art. 95,"—but he has it, "*Instead* of p, either equation 7 of the present article, or equation 18 of article 95 might be employed." The impossibility of employing p instead of an equation (!) we should think would have led the translator to the discovery of his error, if indeed he was translating with any idea whatever of the sense of his author.

In Art. 71, we read, "The time $t-T$, within which the light traverses the mean distance of the earth from the sun which we take for unity, will be the product of the distance Pa into 493^s." Without any reference to the original, the blunder here is obvious. Remembering only that Pa is here the distance of a planet P from a point of observation a, the meaning is: "The time $t-T$ will be the product of the distance Pa into 493^s, within which (i. e. 493^s) light traverses the mean distance of the earth from the sun which (mean distance) we take for unity." Moreover this is the verbatim rendering of the original.

The last sentence of Art. 109 stands thus in the original: "In tali casu etiam ad solutionem problematis supra tractati, (art. 85—105) adhiberi possent: sed quoniam, nostro judicio, ne tunc quidem brevitatem solutionis supra traditae praebent, huic methodo fusius exponendae non immoramur." The subject of the verb *adhiberi possent* is here certain series just treated of in this article 109; and the plain meaning is that "In such a case they (these series) might also be employed for the solution of the problem treated of above (art. 85—105): but inasmuch as, in our opinion, they do not then afford the brevity of the solution above given (viz. in art. 85—105) we do not dwell more fully upon this method" (viz. upon the method by series.) Capt. Davis renders it thus: "In such a case, the methods previously discussed (art. 85—105) might be employed for the solution of the problem: but, as in our judgment, they do not furnish the brevity of the solution given above, we do not dwell upon the further explanation of this method," which is nothing but confusion, involving contradiction, and so far as it would convey any meaning to a merely English reader, would convey the opposite to what Gauss intended.

In Art. 157 there is another instance of the translator's misinterpretation of the meaning of the Latin word "pro," to say nothing of the ignorance it shows of the subject treated of. The Latin is: "In formulis art. 140 pro a, b et $\frac{b}{a}$ ipsos $\sin\delta$, $\sin\delta'$, $\sin\delta''$, retinere opertet, et perinde in formulis art. 142:" which means: "In the formulas of art. 140 for (computing) a, b and $\frac{b}{a}$, and also in the formulas of art. 142, $\sin\delta$, $\sin\delta'$, $\sin\delta''$, themselves, must be retained." But Capt. Davis says: "In the formulas of art. 140 $\sin\delta$, $\sin\delta'$, $\sin\delta''$ must be retained *instead of* a, b *and* $\frac{b}{a}$, and also in the formulas of Art. 142."

We could add instances of slight misapprehensions, which however would not arrest the reader. It is to be regretted that the translator was not as fortunate in obtaining some one to revise his text as he was in getting his formulas rectified. Nevertheless, the formulas being correct (even more correct than in the original) and the meaning of the text being in the majority of cases sufficiently apparent, this publication will be of great value to those students who are unable to read the Latin; and even to those acquainted with the original work, it will be a convenience to have the subjects comprising the Appendix of the translation brought together. Nor must we forget that to Capt. Davis we owe the appearance of the only translation that has been made.

V. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *Twelfth Meeting of the American Association for the Advancement of Science.*—The twelfth meeting of the American Association opened at Baltimore on Wednesday, the 28th of April last. On the absence of both the President and Vice President, Prof. Caswell, the presiding officer of the preceding year, took the Chair, and by vote, was subsequently requested to preside through the meeting. As the Spring is less favorable for a scientific gathering than the Summer, the number present was not quite as large as usual, and there was a corresponding effect on the scientific contributions. The Mayor, Maryland Institute, Historical Society, and many generous citizens of Baltimore, contributed liberally to the interests of the occasion.

The meeting adjourned on Tuesday, the 5th of May, to meet at Springfield, Massachusetts, on the first Wednesday of August, 1859. Professor Stephen Alexander of Princeton, was chosen President for the ensuing year, and Professor Edward Hitchcock of Amherst, Vice President.

The following is a list of the papers presented at the meeting:

I. *Astronomy, Physics, Mathematics.*

Researches in Analytic Morphology. Part First of a New Theory of Curves. By Benjamin Peirce.

Note on the Atlantic Cotidal Lines; derived from the Equilibrium Theory. By Benjamin Peirce.

The Tides of Saturn's Rings. Part I. By Benjamin Peirce.

Researches in Analytic Morphology. Supplement. By Benjamin Peirce.

Further Remarks on Systems of Coördinates in a Plane. By Thomas Hill.

On the Australian Instrument, called the Boomerang. By Joseph Lovering.

On a Supposed Personal Equation in Determining Latitudes, by Talcott's Method. By A. D. Bache.

On the Currents of New York Bay near Sandy Hook. By A. D. Bache.

Comparison of the Committee Metre of the American Philosophical Society, with other Standards. By A. D. Bache and J. E. Hilgard.

On the Results of Dr. Kane's Magnetic Observations in his Second Arctic Expedition. By A. D. Bache and Charles A. Schott.

On the Extinction of Light from Terrestrial Objects. By L. W. Meech.

On the Electrical Phenomena of certain Houses in New York. By Elias Loomis.

On the Electrical Phenomena of certain Houses in N. York. By Samuel St. John.

Note on Curvature. By William Watson.

On the Effect of Sound that is produced in different Stages of the Atmosphere. By A. B. Engstrom.

On the Dynamics of Ocean Currents. By E. B. Hunt.

On Anomalies in the Florida Gulf Stream, and their further investigation. By E. B. Hunt.

On the Cause of the Rotation and Orbital Motion of Extensive Revolving Storms. By E. B. Hunt.

On the Mean Distances of the Periodic Comets. By Daniel Kirkwood.

On the Curve of Swiftest Descent. By Stephen Alexander.

Note on some Daguerreotype Impressions of the Sun's Image. By S. Alexander.

On the Harmonies of the Solar System. By Stephen Alexander.

On a Criterion applicable to the Question of the Common Origin of the Asteroids, and, possibly, also of certain Comets. By Stephen Alexander.

Observations made at the Falls of Niagara, Sept. 1st, 1857. By Joseph Henry.

On the Application of the Rotary Mirror to the Aneroid Barometer. By Joseph Saxton.

Note on Oceanic Currents. By James D. Dana.

Some Experiments on Sonorous Flame, with Remarks on the Primary Source of the Vibrations. By William B. Rogers.

On Ring-Formations in Gases and Liquids. By William B. Rogers.

On Distribution; The Phyllotaxis Deduced from the Mathematical Definition of Distribution. By Chauncey Wright.

On Deep-Sea Soundings—Discussion Showing the Influence of the Resistance of the Water on the Sounding Weight and Line. By W. P. Trowbridge.

An Observation of the Sonorous Vibrations of Coal Gas Flames. By A. M. Mayer.

On the Pendulum, with a Description of an Electric Clock. By F. A. P. Barnard.

A Note in relation to Further Researches on the alleged Influence of Solar Light on the process of Combustion. By John LeConte.

II. *Meteorology.*

On the Geographical Distribution of the Places from which Meteorological Observations are reported to the Smithsonian Institution. By James H. Coffin, (in behalf of the Secretary of the Institution).

On the Currents of the Atmosphere. By James H. Coffin.

A paper in Advocacy of a great systematic chain of simultaneous Meteorological Observations throughout the whole of the American Continent. By R. Lachlan.

Winds and Rains of California. By H. G. Warner.

Report on Atmospheric Electricity—Part First. By Joseph Henry, Secretary of the Smithsonian Institution.

On the Meteorology of Mosul. By W. F. Williams.

On a supposed protracted Perturbation in the Atmospheric Pressure, in the Region of the White Mountains, by an Extensive Conflagration of Forests. By Arnold Guyot.

Note on Certain Iridescent Phenomena upon Lake Michigan. By Geo. W. Burnap.

Climate of North America. By J. B. Hurlburt.

III. *Geology, Geography.*

Rocks of Kansas. By G. C. Swallow.

Synopsis of the Ichnology of New England. By Edward Hitchcock.

Description of the Coal Beds near Fort Belknap, in Texas, with the subjacent and superincumbent Strata, and the discovery of Fusulina Limestone there, in a communication from Dr. Francis Moore to Edward Hitchcock.

Upon the Thickness of some Metamorphic Strata in Vermont and Massachusetts. By Charles H. Hitchcock.

Remains of the American Mastodon, found on Long Island, near New York. By J. C. Brevoort.

The Chemical Constitution of the Chatham Series, in the Valley of Deep River, in North Carolina. By E. Emmons.

On the True Elevation of the Culminating Points of the Appalachian System in the Black, the White and the Green Mountains. By Arnold Guyot.

Permian Rocks of Southern Illinois. By A. H. Worthen.

Observations upon the Genus Graptolithus and allied Genera. By James Hall.

Observations upon the Genus Meganteris and other Palæozoic Brachiopoda. By James Hall.

Formation and Age of Burlington Heights at Hamilton, Canada West. By J. B. Hurlburt.

On the Earthquake which occurred in Western New York and vicinity on the 23d of October, 1857. By Charles West.

On the General Features in the Configuration of the Bays, Sounds, Capes, Islands, &c. of the Eastern Coast of the United States, and on their Classification. By Dr. J. G. Kohl.

The Geological Map of Pennsylvania. By H. D. Rogers.

IV. *Chemistry, Mineralogy, Zoology.*

On the Theory of the Polyacid Bases. By Wolcott Gibbs.

Notice of New Bases, containing Metals and the Elements of Ammonia. By Wolcott Gibbs.

On the Preparation of some pure Sulphates, and particularly of Sulphate of Copper. By Henry Wurtz, of New York.

Some Chemical Examinations connected with a Bullet, imbedded for more than forty years in a Man's Lung. By Henry Wurtz.

Some Improvements in the preparation of hard minerals for Analysis. By Henry Wurtz.

Some Suggestions regarding new applications of Glycerine. By Henry Wurtz.

On modes of increasing the heat of the Mouth Blow-pipe, and some new Blow-pipe Manipulations. By Henry Wurtz.

Abstract of an Investigation on the action of hot Nitric Acid on the Metallic Chlorids, with a New Method for the separation of Magnesia from the Alkalies. By Henry Wurtz.

On the action of Nitric acid in the cold upon some Metallic Chlorids, with new modes of obtaining Pure Compounds of Barium, Strontium and Cadmium. By H. Wurtz.

On the Detection of Nitric acid, with observations on the action of Sesquisalts of Iron upon Indigo and Metallic Gold, and on the Neutralization of the Colors of Metallic Solutions; with some Experimental Illustrations. By Henry Wurtz.

Preliminary Notice of an Investigation upon the action of hot Chlorohydric Acid on the Metallic Nitrates. By Henry Wurtz.

On the Occurrence of Cobalt and Nickel in Gaston county, North Carolina. By Henry Wurtz.

On the Solubility of the Phosphates used in Agriculture, and their Assimilation by Plants. By A. Snowden Piggot.

On the Character, Natural Relations and Relative Rank of the Primary Divisions of the Vegetable Kingdom, founded on Differences of Structure; and especially on the true rank of the Class of Gymnosperms. By Arnold Guyot.

Marine Phosphorescence. By H. G. Warner.

Introductory Remarks to the Psychology of Animals. By D. F. Weinland.

Notice on the production of Heat by the Formation of Cells. By G. Habich,—communicated by D. F. Weinland.

Notice on two new Human Cestoda. By D. F. Weinland.

V. *Philology, Miscellaneous Papers.*

Analysis, Classification, and Representation of the Sounds of the English Spoken Alphabet. By Wm. D. Whitney.

Notice of an Arabic Work on Physical Science, of the Twelfth Century. By W. D. Whitney.

On the Insensible Gradation of Words in Comparative Philology; illustrated by five charts. By J. P. Lesley.

Signs of Significance—like Symbols for a Language—in Fanciful Rock-work—the Stone Spear and Arrow Heads of the Catawbas. By J. H. Gibbon.

Distinct Tones and Accents of Voice—with Special Signs—explain sensible emotions from Mute Animals to each other. By J. H. Gibbon.

Certain Identities between Dead Languages and Existing Alphabets. By J. H. Gibbon.

A Method suggested for Teaching Notes of Music to Negro Boys, not instructed to read. By J. H. Gibbon.

On Wethered's Application of Combined Steam. By C. E. Wethered.

Grape Culture in Missouri. By G. C. Swallow.

On the Establishment of a Mathematical Journal. By J. D. Runkle.

Observations upon the Practicability of reaching the North Pole. By Isaac I. Hayes.

Antiquities at Grave Creek—Inscribed Stone—Explorations at the West. By Dr. Wills De Hass.

Application of the Principles of Caloric to the construction of Warm Air-Furnaces. By James Bolton.

On the Confirmation, from Providence data, of a newly determined law of mortality for Early Childhood. By E. B. Elliott.

On some points of inquiry that may be properly introduced in the Federal Census. By Franklin B. Hough.

Concerning the number of Telegraphic Conductors that may connect with a single Battery, at an extreme station, without sensible interference. By E. B. Elliott.

On the Causes of the Variable Illuminating Power of Coal Gas. By W. E. A. Aiken.

On Recent Efforts to Deepen Maffit's Channel across the Bar of Charleston Harbor. By P. N. Lynch.

On the Telegraph and the Telegraphic Lines of the World. By Lawrence Turnbull.

On the production of Local Anæsthesis, by a novel application of Current Electricity. By C. P. Williams.

On the Calculation of the Earth-work of Railroads, &c. By W. M. Gillespie.

2. *The Mathematical Monthly.*—Mr. J. D. Runkle of Cambridge, Mass., connected with the Nautical Almanac office at that place, has issued a Prospectus of a Mathematical Journal with the above title. It is to be handsomely printed in small quarto form, and issued in monthly numbers of at least twenty-four pages. Mr. Runkle expresses his idea of the proposed journal in his Circular as follows:

"It seems to us that such a journal is needed; one that shall embrace, among its contributors, the best talent, in order that younger laborers in the same field may always have before them a high standard of excellence, and that it may be a fair index of the mathematical ability of the country. On the other hand, however, care should be taken not to graduate it, as a whole, too high above the average attainments of mathematical students; otherwise, only the few would be interested in it or benefited by it. It should therefore embrace in its pages solutions, demonstrations, and discussions in all branches of the science, as well as in all its various applications.

"It should contain notes and queries, notices and reviews, of all the principal mathematical works issued in this country, as well as in Europe.

"In short, it should be the medium of all kinds of information pertaining to the science, to which a large proportion of our mathematical students have at present no ready access.

Mr. Runkle has also in view to issue prizes for prize problems and mathematical essays.

The Journal is one very much needed in the country, and should succeed. Its plan is ample and generous, and the known ability and energy of the editor will give it character and success, if the country will sustain him. Annual subscription per single copy $3,00.

3. *Proceedings of the American Pharmaceutical Association at its Sixth Annual Meeting, held in Philadelphia, Sept.* 1857. 8vo, pp. 178. —This session of the Association appears to have been more fully attended than previous ones, and quite fruitful of questions proposed for future investigation. Scientific reports were made on various important subjects, affording gratifying evidence of the zeal and ability of its members. Among these, that on the "Progress of Pharmacy" is very full, giving a comprehensive *resumé* of the improvements and discoveries in practical chemistry, pharmacy and materia-medica during the year.

That on "Improvements in methods of rendering medicinal preparations pleasing to the eye and to the taste, and agreeable to use," contains information of great practical importance to all dispensers of medicines, and if adopted by them would largely increase their trade, while contributing still more to the comfort of the sick. It has frequently been to us a matter of wonder that so little attention is paid to this subject by apothecaries generally, while every consideration of humanity, refinement and taste demands it.

A report on "Weights and Measures," one on "New England Isinglass," and another on the "Manufacture of Iodine from the ashes of sea-weeds," are valuable and compare favorably with reports of other scientific associations. A voluntary paper on "Ethical Analysis," by Edward Parrish, is an excellent *beginning* for a more extended article on the *ethics of the profession*—a subject which ought to be brought more fully and frequently under consideration. This must necessarily result however, in due time, from the efforts of the Association to elevate and advance the calling of the apothecary from the position of a mere trade to that of one of the professions—a dignity to which we hope soon to see it attain.

4. *Geographical Society of London.*—The Victoria medal of the Geographical Society has been awarded to Alexander Dallas Bache, Superintendent of the Coast Survey.

5. *Geological Society of London.*—The Wollaston medals of the present year have been conferred by the Geological Society of London on Hermann von Meyer of Frankfort-on-the-Maine, and Professor James Hall of Albany.

6. *Addendum to the article on the U. S. Coal Measures* (p.112).—According to E. T. Cox, coal bed No. 9 contains the fossils *Avicula recta-lateraria, A. acosta, Solenimya soleniformis, Nautilus decoratus, Productus muricatus, Nucula Hameri, Pleurotomaria Grayvillensis, Chonetes mesoloba, Productus equicostatus, Bellerophon carbonarius* (*B. Urii* of other American authors), etc. Bed No. 11, contains, *Loxonema regularis, L. Halli, Chemnitzia parva, Pleurot. Bonharborensis, P. depressa, Arca carbonaria, Gervillia longispina, Macrocheilus gracilis, Orthis resupinoides, Avicula*

rectilateraria, Macrocheilus inhabilis, Productus muricatus (rare), *P. Rogersi, P. equicostatus, Athyris subtilita, Spirifer Meusebachanus, Orthoceras* undetermined, etc.

7. OBITUARY.—Dr. JAMES DEANE of Greenfield, died on Wednesday, the 9th of June, at the age of 56. Dr. Deane is known to the geologists of the country by his papers on the Footprints of the Sandstone rocks of the Connecticut valley. The first specimens seen by Prof. Hitchcock were brought to him by Dr. Deane. Since then the subject has grown into one of great importance to American geology, and Dr. Deane has contributed his part to this result. For the year or two past he has been engaged upon a great work on these Footprints, illustrated by lithographs and photographs made by himself. His lithographed drawings were very numerous and exceedingly faithful and life-like, and it will be a great loss to science if they fail to be published. His photographs also were excellent. Among the most interesting are photographs of the insect tracks of the same rocks, which he had brought into comparison with recent tracks of water insects, by means of photographs of the latter also. There are others which have, as he thought, a strong Marsupial look. The series of illustrations which he has prepared, even if without text, would make a volume of great beauty and scientific value.

ERASMUS D. NORTH, M.D., formerly of New Haven, Ct., died at Westfield, Massachusetts, on the 17th of June, aged 51 years. Dr. North was one of the best amateur microscopists of the country, and contributed valuable papers to this Journal on the construction and improvement of microscopes. He was a man of extensive knowledge also in other departments of science. For many years he occupied with ability the post of Instructor of Elocution in Yale College, and in that time he published a work on the subject, displaying a thorough acquaintance with its principles and practice. He leaves behind an unfinished life of Percival, the poet and geologist; and a double loss has therefore befallen the country in his decease.

Dr. WILLIAM GREGORY, the distinguished Professor of Chemistry in the University of Edinburgh, died on Saturday evening, June 24, 1858. Dr. Gregory had suffered for many years from rheumatic seizures, and had been unable to lecture during the past winter session. He died in the prime of life, and has left behind him a widow and an only son.

JOHANNES MÜLLER.—The University of Berlin has to bear a heavy loss. One of its most celebrated members, Prof. JOHANNES MÜLLER, the physiologist, died suddenly of apoplexy, on the 28th of April, not quite fifty-seven years old. Müller was born at Coblenz, on the 14th of July, 1801, and had been living at Berlin ever since 1833.

TRANSACTIONS OF THE ACADEMY OF SCIENCE AT ST. LOUIS. No. 2, of vol. I. 303 pp. 8vo, with plates. St. Louis, Missouri. Price $1.00.—This number of the Transactions of the Academy of Science at St. Louis is especially remarkable for the importance of its geological papers. We have already cited from several of them in this and our preceding volume. The contents are as follows:

B. F. SHUMARD, M.D.: Tertiary and Cretaceous fossils of Oregon and Washington Territories and Vancouver's Island.—T. C. HILGARD, M.D.: Exposition of a Natural Series by Intermediate Catholic Affinities in the Vegetable Kingdom.—G. C. SWALLOW: Grape Culture in Missouri.—A. WISLIZENUS, M.D.: Was Man Cotemporaneous with the Mastodon?—F. HAWN: The Trias of Kansas.—G. C. SWALLOW and F. HAWN: The Rocks of Kansas [see above, p. 115].—B. F. SHUMARD and G. C. SWALLOW: Descriptions of new Fossils from the Coal Measures of Missouri and Kansas.—H. A.

PROUT, M.D.: New species of Fossil Bryozoa (Genera, *Fenestella* and *Eschara* from the Carboniferous limestone of the Organ Mountains, New Mexico, and new genus *Fenestralia* from the upper layer of the St. Louis Limestone.)—B. F. SHUMARD: New species of Blastoidea, [see above, page 127].—G. SEYFARTH, D.D.: A remarkable seal in Dr. Abbot's Egyptian Museum, at New York.—H. A. PROUT: New Bryozoa from the Palæozoic rocks of the Western States and Territories.—G. G. SHUMARD: Geology of New Mexico.—G. G. SHUMARD: New Fossils from the Permian of New Mexico and Texas.—SPENCER SMITH: On the formation of Hail.—ENGLEMANN and WISLIZENUS: Meteorological Observations for 1857.

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